How to Help Home Owners

...a working guide for the Shelter Industry

About this book . . .

Whether you are a builder, an electrical contractor, an architect, electrical appliance dealer or distributor, banker, realtor, electrical dealer or electric utility engineer, you and your organization have a tremendous stake in the nationwide program to help American homeowners LIVE BETTER . . . *Electrically*.

Through your cooperation and your support this program will benefit you directly even as it helps promote a better standard of living throughout the nation.

This book has been published to help you advance the LIVE BETTER . . . *Electrically* concept in your own community. In these pages is working material for every business group concerned with home construction, modernization and community development.

LOAD-MATCHED WIRING A KEY TO SUCCESS

Certainly a vital key to the success of the LIVE BETTER . . . *Electrically* program is an intelligent approach to the residential wiring problem. Such an approach is outlined here, which represents a new concept of home wiring based on usage, convenience and future needs, as well as improvement of property values. This concept has been appropriately named Load-Matched Wiring, and is fully described and illustrated herein, and supplemented with appropriate technical information for the electrical contractor and for his business allies as well.

Much is being done currently to advance the cause of modern home wiring. Electric utilities, the National Adequate Wiring Bureau and others, have long been working to this end. The Edison Electric Institute is promoting better wiring for homes under the name "Housepower."

The Load-Matched Wiring concept—and this book—will work in concert with other national and local efforts to help America LIVE BETTER . . . *Electrically*.

CHAPTER I

ELECTRICAL LIVING:

A 20th-Century Evolution

At the beginning of this century less than 2% of the homes in the United States were wired for electricity! Yet today, thanks to a wealth of electrical marvels, we are entering an era of "push-button living."

Electricity can heat our homes, warm our blankets (and baby's bottle), supply us with limitless hot water, cook our meals, and wash and dry the dishes afterwards.

Electricity can cool our homes, freeze our food, cool, dry and circulate our air, make ice cream, and give us a limitless supply of ice cubes.

Electricity can wash, dry and iron our clothes, clean house, entertain us and light our rooms so they'll glow with charm and cheer.

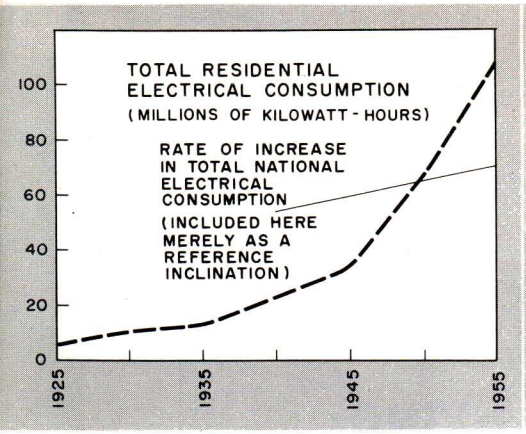
Homes enjoying all of today's electrical possibilities are far from commonplace. But, in all sections of the country, countless "idea homes" and "possibility rooms" have been constructed and sponsored by manufacturers of electrical products and equipment, power companies, architectural associations, electric leagues and builders. Public interest in these homes is keenly evidenced. The desire to LIVE BETTER . . . *Electrically* is growing steadily, as is the demand for more residential wiring and more electric power.

PROGRESS

Since 1925, total residential electric consumption has climbed from 6 to 118 million kilowatt hours. During the past decade, *residential* consumption has jumped 250%. During the same period, the total national consumption for all purposes has climbed 133%. In other words, the residential load has been increasing approximately *twice* as fast as the over-all average. (See Chart I).

This growth is due to two things. First: the total number of electrically serviced homes in our country has increased from 15 to 44 million during the past 30 years. Second: the annual consumption of the average customer has climbed from 400 to over 2700 kilowatt hours.

The slope of the "number of customers" curve is now beginning to level off. This is to be expected, since most existing homes in the United



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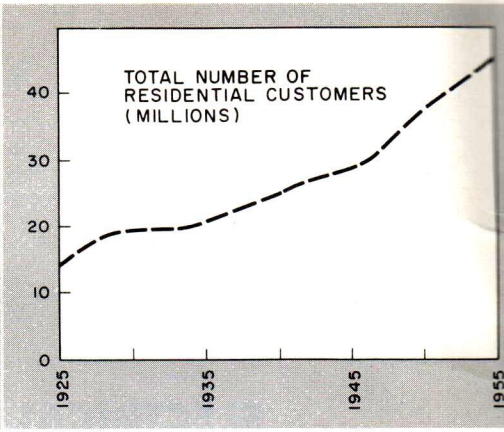
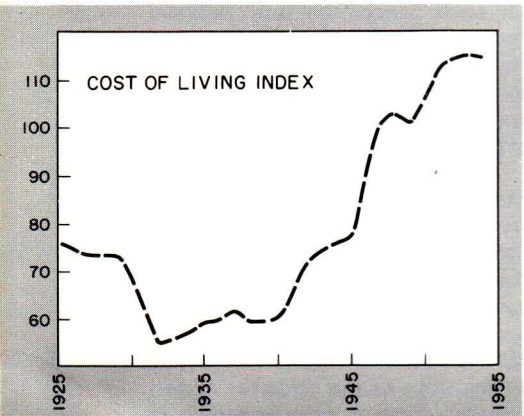


II

States (98%) have now been wired for electric service.

Nevertheless, there are no indications that the customer *consumption* curve will falter. Home owners are presently stepping up their use of electricity by 220 kwhr per year. This tremendous increase in the use of electricity has also increased the amount of the average customer's annual electric bill from $30 to $72 since 1925 (Chart IV). This increase is not as great as it appears to be, when we check it against the Cost of Living Index (Chart V). Here we see that the purchasing power of a 1925 dollar is now around 66 cents. So when equated to comparable values, the effective annual charge today is only 60% greater than it was three decades ago. In other words, the average use of electricity has increased 6 times, yet the average bill has only little more than doubled. As Chart VI shows, the cost of current continues to drop. Average residential rates have been reduced more than 60% in the 30 years represented by



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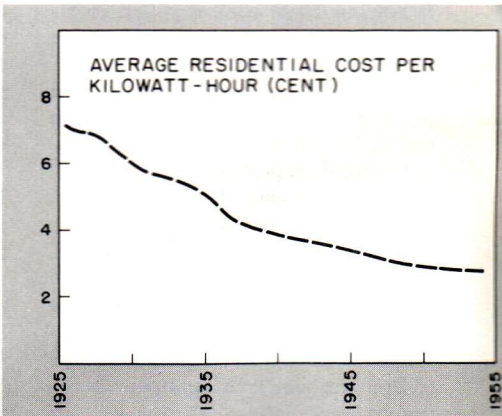
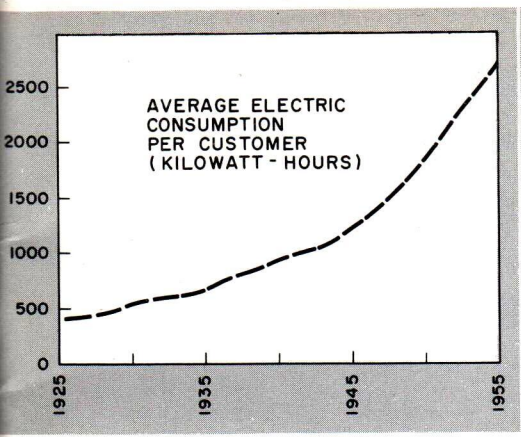


VI

SOURCE McGRAW-HILL PUBLISHING CO.



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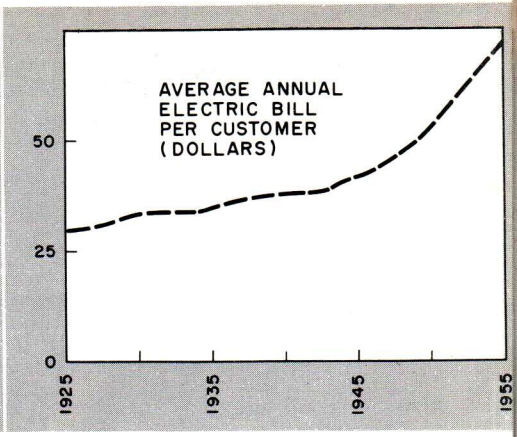


IV

these charts. Thus one of the greatest bargains to be found in this era of generally rising costs is electric heat, light and power.

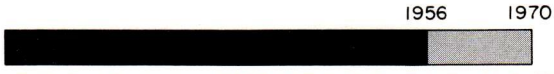
In plotting these various curves, the year 1925 was chosen as reference point because approximately half of all the homes now existing in the United States were constructed before 1925. This indicates that the great majority of homes built and wired prior to that year (when, remember, the average customer's consumption was only 400 kwhr) are woefully *under* wired for present residential requirements.

FORECAST OF A FABULOUS FUTURE

National population is increasing at the rate of nearly 3 million a year. At this rate our 1970 population will be 205 million. Moreover as the post World War II babies mature and marry, housing requirements are expected to boost residential building rates to around 1½ million units annually. This will mean approximately 60 million residential customers by 1970.

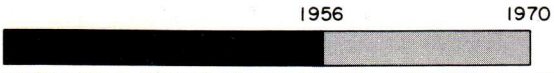
Our national production level is expected to increase by nearly half—should reach $567 billion—by 1970. This gigantic boost is expected to increase our per-capita income by almost a third (after taxes, to about $2200). It is predicted that consumer spending will be directed in increasing measure to those purchases which provide greater comfort and convenience. In other words, people will want to LIVE BETTER . . . *Electrically*.

POPULATION: PREDICTED TO JUMP FROM 168 TO 205 MILLION INHABITANTS IN U.S. IN NEXT 15 YEARS



HOME BUILDING: BUILDERS ANTICIPATE THAT HOME REQUIRMENTS WILL RISE FROM PRESENT RATE OF 1.2 TO 1.5 MILLION UNITS

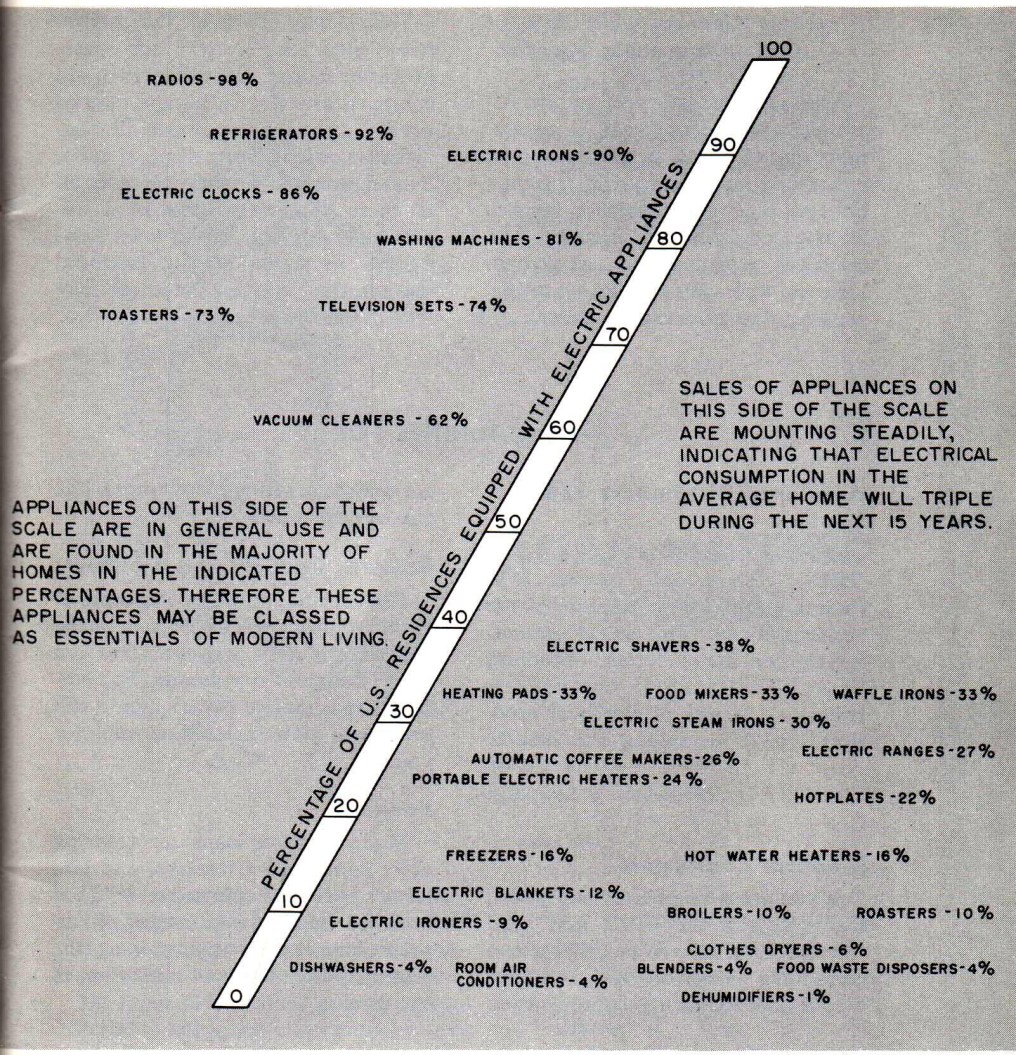
RESIDENTIAL CUSTOMERS: NEXT 15 YEARS WILL SEE INCREASE IN NUMBER OF CUSTOMERS FROM 45.5 TO 60.4 MILLION



DISPOSABLE INCOME AFTER TAXES: EXPECTED TO INCREASE FROM 272 TO 447 BILLION DOLLARS

AVERAGE CONSUMPTION PER CUSTOMER: PREDICTED TO INCREASE FROM 2990 TO 7700 KWHR ANNUALLY

This will lead to more appliance sales; greater use of electricity. By 1970, it is estimated the average electric customer will be using more than 7700 kilowatt hours of electricity a year. The rate of increased use by that time will be in the order of 460 kwhr per year! By today's standards that figure is a sizeable jump, yet it should be remembered that this jump is just the "average." Above this level will be countless homes equipped with year 'round air conditioning, electric heating, and many devices and appliances not yet on the market. So, it is entirely possible that many homes will approach the annual consumption level of 30,000 kwhr in the next 10 years!



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LUXURIES BECOME ESSENTIALS

Every one of the electrical necessities in our homes today were once considered luxuries. They were introduced as luxuries and bought by the few who could afford them. Soon, cooperative industry-wide promotion brought their many advantages to the attention of everyone . . . today few homes are without them. For example:

Refrigerators. Only 8% of today's homes are without one.

Television, a relative newcomer, is to be found in all but 26% of our country's residences.

Vacuum Cleaners. Only 38% of American households lack them.

This repeated story of public resistance giving way to public acceptance is of vital importance. It indicates that industry-wide promotion pays off with benefits for all. It also indicates that many other electrical products now considered luxuries, will soon graduate into the growing class of necessary items.

Today only 16% of our homes have either an electric hot water heater or freezer. Less than 10% are equipped with electric ironers, clothes dryers, dish washers, room air conditioners or food waste disposal units. Sales figures and growth curves for all of these appliances have been impressively steady. Yet, when considered in terms of the potential market, they indicate the future may well dwarf the present.

OPPORTUNITIES FOR:

Appliance Distributors and Dealers

One objective of the LIVE BETTER . . . *Electrically* program is to maintain the rate of increase of the residential load. This means promoting the benefits of electrical products on an all-out scale. If your business concerns the sale of electrical products, you'll be among the first to reap the rewards of the LIVE BETTER ... *Electrically* campaign.

Electrical Contractors

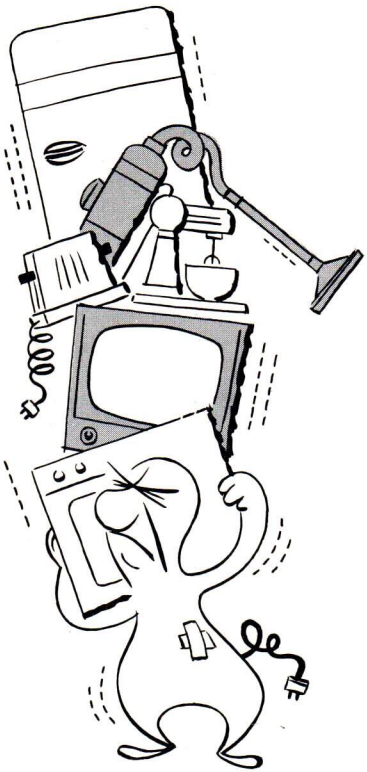
If you are a member of this group, the success of the LIVE BETTER . . . *Electrically* campaign promises continuing years of good business. You'll find increasing opportunities, not only in rewiring older homes, but also in new construction.

Builders, Realtors and Architects

The acceptance of new concepts of electrical usage will allow you, in the building industry, a greater freedom in the design of new homes. In addition, the complete electric home will provide a powerful selling tool for you.

Bankers

Modernization loans for rewiring older homes are attractive, and you know appliance financing is good business. Lending institutions will also be interested in maintaining the relatively high levels of borrowing in the coming years.



The concept of Load-Matched wiring (covered in Chapters II, III and IV) is a realistic recommendation for the immediate future. It goes beyond presently accepted standards of adequacy. It is designed to give families the "Housepower" they need to Live Better . . . Electrically.

CHAPTER II

LOAD-MATCHED WIRING

Today's American families want to live better. Most people appreciate the many ways electrical products can make housework easier—home-life more pleasant. So this growing desire to live better electrically brings with it a growing demand for modern home wiring systems. When properly planned and engineered to handle a particular load of electrical appliances and lights, a modern wiring system is as much a source of better electrical living as the electrical products themselves. In other words, no combination of home electrical products can be any better than the wiring system which supplies them.

A modern home wiring system must be designed to suit prevailing conditions, such as:

—size of the house and size of the family it will accommodate.

—conditions imposed or recommended by electric codes and ordinances.

Both these factors should be carefully considered in wiring new homes —whether built for a specific family or mass produced—or modernizing old ones.

The primary objective of wiring design is to provide a system "matched" to modern standards—to existing and anticipated electrical loads.

This book has been prepared as a guide to design and layout of "load-matched" wiring systems, applying to both new construction and

modernization. This presentation sets standards for design of various system elements. Standards for circuits, service arrangements, load center layouts and actual wiring techniques are established for typical residential wiring systems.

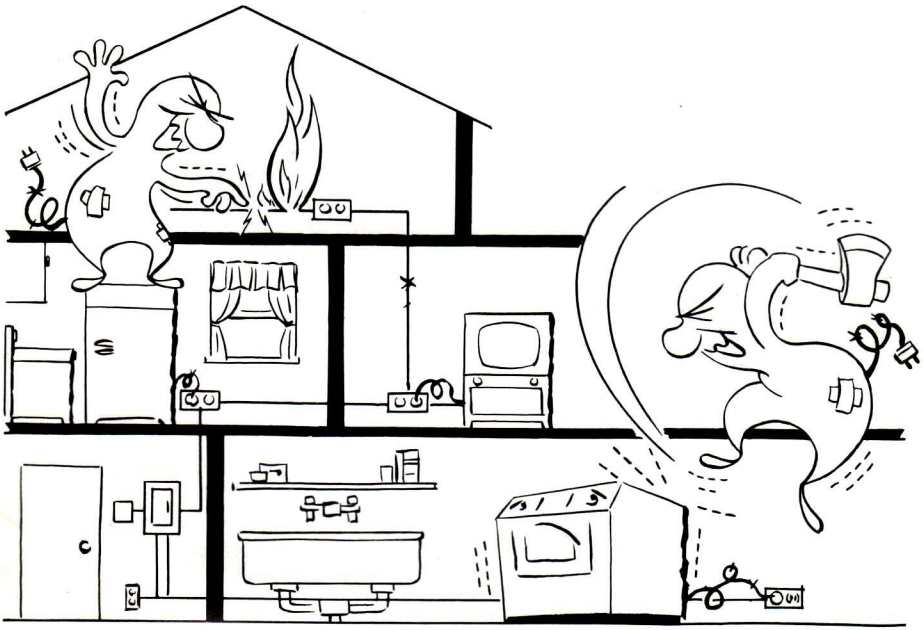
LOAD-MATCHED WIRING SYSTEMS

Most homes today are inadequately wired to handle even the minimum number of appliances which are considered essential.

Many new homes are equipped with wiring systems which are initially inadequate.

If a homeowner is to know the convenience and enjoyment of modern electrical living his home must be equipped with a wiring system capable of handling immediate and future loads. Establishment of the immediate and future load requirements in terms of specific appliances and devices will provide a basis for a modern wiring system.

Years ago, when the number of electrical appliances and products for the residential market was only a fraction of what it is today, a home was wired for lighting and a few appliances—washing machine, toaster, radio, ironer. The wiring installation was made according to code safety standards. Wiring systems in those days offered sufficient convenience, flexibility, and safety as provided by the code. But, as more and more electrical products were made avail-



NATIONAL ELECTRICAL CODE

This Code contains basic minimum provisions considered necessary for safety. Compliance therewith and proper maintenance will result in an installation essentially free from hazard, but not necessarily efficient, convenient, or adequate for good service. This Code is not intended as a design specification nor an instruction manual for untrained persons.

able to the home, these wiring systems soon lost their convenience and flexibility.

Although safe by technical standards, many code-wired homes are not realistically safe. When new appliances are added the homeowner, for lack of understanding, begins to strip safety from the system. If a fuse blows, he often puts in a larger fuse. If there are not enough outlets "cube taps" are inserted in single-plug receptacles. And extension cords, and more big fuses, and more "octopus" outlets are added.

The National Electrical Code is a basic minimum standard to safeguard persons and property from the hazards of electricity. It is not a design or specification manual. The National Electrical Code and local codes should always be observed in engineering a home wiring system to assure safety in operation. But maximum convenience and safety with load growth can be designed into a wiring system only by observance of sound and realistic standards.

Realistic minimum requirements have been developed for residential wiring systems including design standards for branch circuits, feeders, protective devices, and service entrance arrangements. No conflict with the National Electrical Code is represented in these requirements. They are set forth to complement the code, to assure convenience, efficiency and long-range economy as well as safety. These standards offer a "load-matched" wiring system.

The major characteristics of "load-matched" wiring systems are:

1. ACCESSIBILITY—Proper types of plug receptacles will be numerous and conveniently located.

2. CAPACITY—All parts of the electrical system will be capable of supplying rated voltage at the full-load current of the circuit. A 20% spare capacity will be included in each circuit over and above its maximum probable load. On a general-purpose circuit, the normal load of lights and portable appliances will not exceed 50% of the rated circuit capacity. This provides sufficient *extra* capacity for temporary port-

able appliances. No probable condition of load will cause overload on any part of the system.

3. ISOLATION—To assure efficiency of automatic operation, most automatic appliances should be served by individual circuits. Lights, television and other devices sensitive to voltage fluctuations should not be served by circuits to which motor-driven or automatic appliances are connected.

4. SAFETY—The system will be safe in compliance with the provisions of the National Electrical Code. "Load-matched" wiring will add a safety-plus to the system, even with substantial load-growth. The homeowner will be able to add new appliances without danger of overloading circuits.

5. CONTROL—The system will include maximum operating convenience. Switches and other controls will be carefully positioned, with a sufficient number suited to family living habits.

In designing a "load-matched" wiring system, the first step is to determine the load. For example, in modernizing, figure the existing load. Next, add the loads of new electrical devices to be installed immediately. Then extra circuit capacity should be added to handle anticipated future loads.

For new homes the amount of initial load to be used involves several considerations. Are only general purpose lighting and small appliance circuits to be served? Will an electric range and electric water heater also be included in the house? What electrical laundry appliances might be used? Does air conditioning and/or electric supplementary or permanent home heating come into the picture? Answers to these questions, plus an allowance for future requirements, will give the total design load.

Design, layout and installation of a "load-matched" wiring system should follow the details and sequence of the remainder of this book. According to the data set forth in the section on branch circuits, every device can be provided with a suitable supply of power. On the basis of a complete layout of branch circuits and loads, a modern service entrance can be selected. Such important design problems as flexible switching and control, selection of wire sizes and wiring devices, lighting techniques, signal systems, electrical space heating, air conditioning and ventilation are follow-up considerations which fill in the framework of branch circuits and service entrance.

CHAPTER III

CIRCUIT REQUIREMENTS

Architects, builders and contractors should acquaint home owners with the importance of a modern electrical system. To ignore or minimize these requirements in their plans is unjust not only to the prospective buyer, but to the building profession as well. To permit an owner to accept through technical ignorance a wiring system which is obsolete can only reflect discredit and distrust upon all parties involved. Therefore it becomes the obligation as well as the opportunity of the construction industry as a whole to familiarize home owners with:

. . . appliance ratings, in terms of commonly-understood watts,

. . . circuit possibilities for maximum convenience, in terms of receptacles, switching arrangements and controls, and

. . . the wisdom and reasons for installing load-matched functional wiring.

It isn't surprising that most home owners are unfamiliar with technical terms like "amperes" and "volts," yet it is true that the majority of people *do* have a vague knowledge that:

. . . watts are a measure of how much electricity an appliance needs,

. . . watts travel over wires buried behind walls, providing power to operate motors, heating and lighting devices, and that the summation of these watts determines:

. . . required size of wires,

. . . capacity of safety devices,

. . . amount of monthly utility bills.

In order to promote clearer, more positive "meeting of the minds" in seller-buyer discussions, therefore, it would be well for sellers to limit their technical vocabularies to terms understood by the average buyer. One such word is the one just defined —"watts."

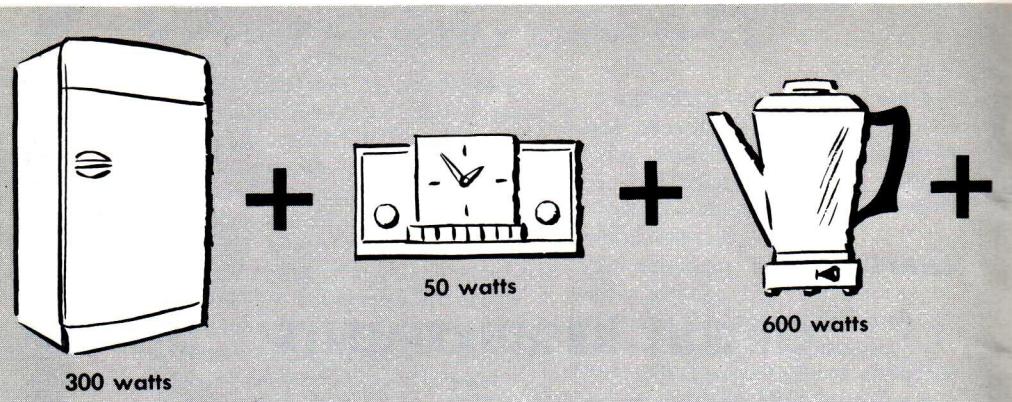
To emphasize relative power by this term, it can be explained that:

. . . 100 watts is the rating for most residentially-popular lamps, or a portable fan or exhaust unit, or a food mixer or radio;

. . . 150 watts is the rating for small 3-way (50-100-150 watt) floor- or table-lamps, or a vacuum cleaner;

. . . 300 watts is the rating for a food-waste disposer, refrigerator, television set, electric blanket or large (100-200-300-w) 3-way lamp;

. . . 500 watts is the rating for a



Sufficient circuits and outlets improve convenience and safety, reduce possibility of overload and power interruptions.

sun lamp, a home freezer unit;
. . . 1000 watts is the rating for a hand iron;
. . . 1200 watts is the rating for a dishwasher, portable heater, food fryer, room air conditioner (¾-horsepower), toaster or clothes washer;
. . . 1500 watts is the rating for a broiler, built-in bathroom heater or tools in the average work shop;
. . . 1650 watts is the rating for an ironer or roaster;
. . . 4000 watts is the rating for a water heater;
. . . 5000 watts is the rating for a clothes dryer, oven or central residential air conditioning system, and
. . . 14,000 watts is the rating for a single-oven range.

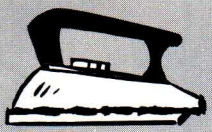
Generally these values are for maximum-sized residential units. Use of these maximum ratings in selecting the number and size of circuits will help avoid future overloads.

Why Worry About Overloads?

Basic knowledge to technicians but a deep mystery to most home owners is the fact that a 20-amp 115-volt circuit has a rating of 2300 watts. Such a circuit installed in a kitchen, for example, could simultaneously serve a thousand-watt hand iron and 1200-watt dishwasher. There would be no additional capacity, but the two units would operate efficiently.

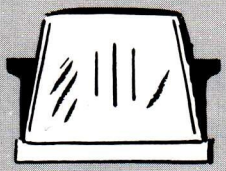
The addition of a 1200-watt toaster, however, would boost the load on the circuit 1100 watts above its rated capacity, causing an overload.

The result would not be dangerous —*if* the circuit were properly sized and protected by a properly-matched fuse or circuit breaker. The only result would be the inconvenience of unplugging one of the appliances, then resetting the breaker or replacing the fuse.



1000 watts

1950 watt load on a 115 volt 20 amp (2300 watt) circuit is OK . . .



but the further addition of an 1150 watt toaster means trouble, resulting in an overload and an interruption of power.

If wires and safety devices were *not* matched and properly rated, the results of overloading could be more serious. For example, voltage would drop, power would decrease, lights would dim, irons and toasters would heat more slowly to lower temperatures, appliances would operate sluggishly, or (if circuits were over-fused), wiring buried in walls could overheat to the fire-hazard stage.

Functional Wiring

A sound approach to the design and layout of an electrical system is important. Probable loads of lighting, heating and appliances should be determined, then circuits and services to handle these loads should be installed. A "load-matched" system prevents overloads, permits unrestricted use of modern electrical servants, and insures the attainment of the five major characteristics—(1)accessibility, (2) capacity, (3) isolation, (4) safety, and (5) control.

Accessibility and Convenience of Outlets

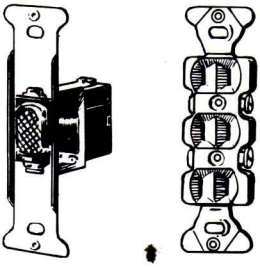
Few homes have a sufficient number of outlets—as is evidenced by the all-too-frequent presence of "octopus" plugs, multiple extension cords and useful-but-unused appliances stored away because no convenient outlets exist in which to plug them. Extension cords were never intended as substitutes for branch circuits or outlets, and they create the hazard of possible tripping—or short circuits due to frayed cords. Rearrangement of furniture and placement of lamps is hog-tied to a few fixed patterns, and the cost of installing additional outlets is far greater than providing an adequate number when building or remodeling.

As to types of outlets, there are standard duplex and triplex convenience receptacles, multiple-outlet strips and moldings, weatherproof outlets with protective caps, hanger outlets for clocks or fans, safety outlets for the nursery room, polarized

outlets to provide a grounding connection for appliances, locking-type outlets to prevent plugs from becoming accidentally detached, and special-purpose outlets such as those designed to receive a range cord set. There are also the outlets for connecting lighting fixtures, frequently overlooked by home owners because they are hidden from view behind the fixtures.

General-purpose convenience outlets should be placed for maximum useability. For example, in living rooms, bedrooms and general living areas, duplex outlets should be placed so that no point along the floor line in an unbroken wall space is more than 6 feet from an outlet. Also, in smaller sections of wall space, segregated by doors, fire places, bookcases or windows, additional duplex outlets should be provided.

In dining areas, duplex outlets should be placed so that no point along an unbroken wall space is more than 6 feet from an outlet at floor line. One should be as near as possible to the chair of the hostess and, in small areas such as a breakfast nook, one should be located near the table slightly above table level.



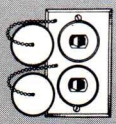
Interchangeable Devices—Any combination of one, two, or three switches, pilots and receptacles fit in a single gang box.

In hallways, convenience receptacles should be installed to serve each 12 feet; and a weatherproof outlet should be provided for each 15 feet of useable outside wall space on porches, terraces and patios.

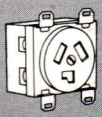
In kitchens and work shops, spacing of outlets should be reduced to 4 feet

WIRING DEVICE CHART

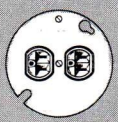
Standard Duplex—"U" slot devices recommended to permit grounding. Split-wired receptacles permit switching of one outlet.



Weatherproof outlet—single or duplex devices have screw-on caps to keep out moisture.

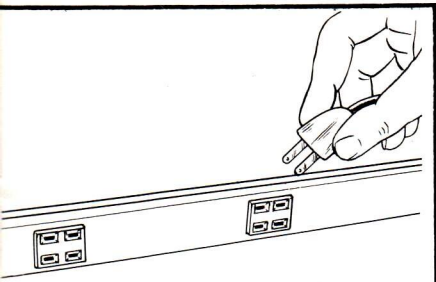


Dryer outlet—30A-250V receptacle may be flush mounted in std. box. Also suitable for work bench power outlet.

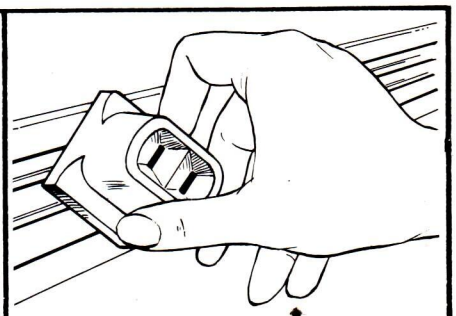


Cover-Mounted outlets—several types of receptacles can be obtained mounted on covers for use with exposed boxes in basement and garage.

Range outlet—3 wire—50-amp, 250-V polarized receptacles available for flush or surface mounting.



Surface Raceway—with built-in outlets at regular intervals. Available ready-made or in components for special application.



Electrostrip—Surface system permits owner installation of outlet at any point.

behind all working counters and benches.

General-purpose convenience outlets should also be located wherever dictated by desire or necessity; such as adjacent to a mirror in a bathroom, at the entrance of a home, the furnace in the utility room, the refrigerator space in the kitchen, or the ironing or washing areas in the laundry.

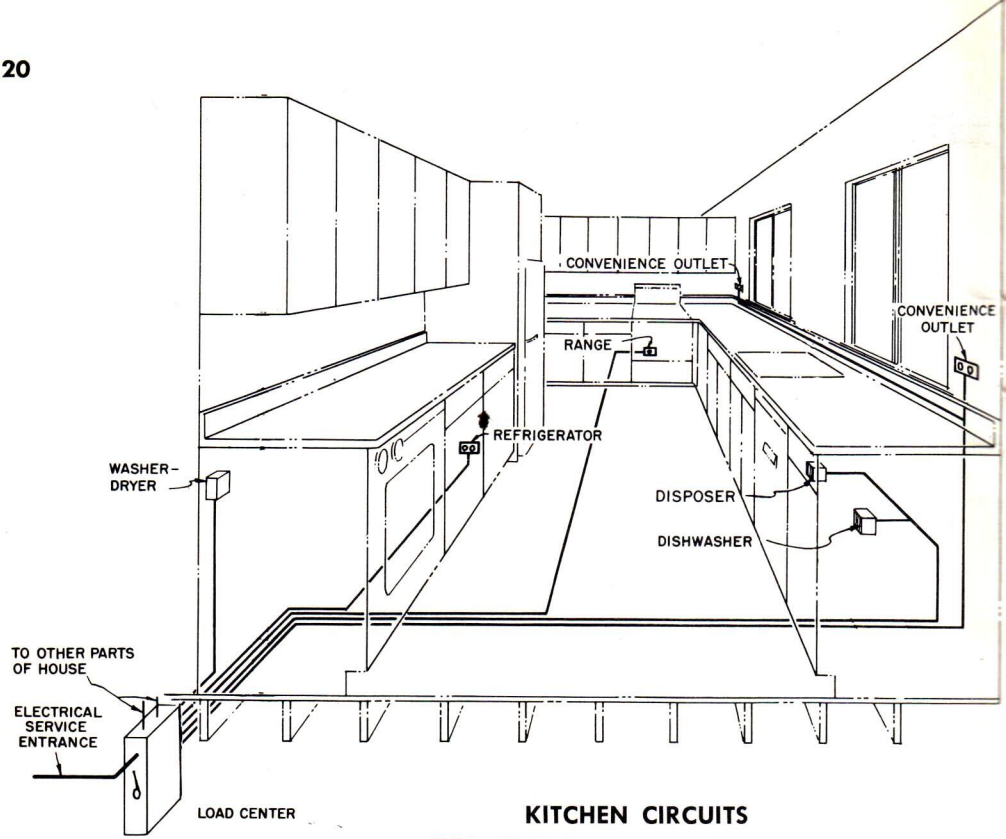
In addition to these convenience outlets, *special-purpose* outlets should be provided for radios and television sets (in living areas); ranges, dishwashers, home freezers, clocks, ventilation fans or food waste disposal units (in kitchens); electric clothes washer or dryer (in laundries); built-in heaters (in bathrooms); electric water heaters or fuel-fired equipment (in utility areas).

Outlets should be provided to serve all permanent lighting fixtures in ceilings, coves or valances, over work areas, in enclosed shower compartments, beside or above mirrors, in closets, over tables, and on stairways.

Types of Residential Circuits

To provide all of the requirements of functional wiring (accessibility, capacity, isolation, safety and control), several types of circuits are essential. This can be appreciated by considering the number of 115- and 230-volt appliances on the market, plus the fact that Code requirements are explicit concerning the provision of separate circuits for lighting, appliances and general-purpose duty. Actually, six types of circuits may be found in modern homes, three each related to 115- and 230-volt service.

The first type of circuit in the 115-volt category serves two or more plug outlets for appliance connection in the kitchen, pantry, dining and laundry areas. This type is designed to serve *appliances only*, and would be used to supply current to coffee makers, food mixers, toasters, griddles and the like. This circuit should be of No. 12 wire, protected by a 20-ampere fuse or circuit breaker, and adequate for loads up to 2300 watts. One such circuit would generally satisfy Code requirements in many instances but, with the quantity and capacity of appliances for the kitchen constantly increasing, builders and contractors should provide *two* such circuits, installed on a 3-wire layout serving split-wired duplex receptacles.



KITCHEN CIRCUITS FOR FREE-STANDING APPLIANCES

The second type of 115-volt circuit is similar to that already described, with the exception that it is a general-purpose circuit; i.e., it serves small plug-in appliances *plus lighting*. This circuit will also have a capacity of 2300 watts. It is designed to serve convenience receptacles in all areas except those covered under the first circuit named, plus lighting in the entire residence.

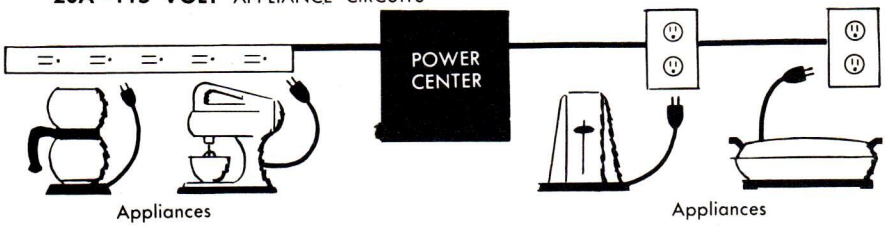
It *may* consist of No. 14 wire backed by a 15-amp fuse or breaker (in which event the capacity would be limited to 1750 watts). However, the added capacity of 12 gauge over 14 gauge wire will be amply justified through improved performance of appliances, the elimination of possible overloads and the absence of interruptions to electrical service.

The third type of 115-volt circuit is also identical to the first type discussed, being a No. 12 wire circuit with 20-amp protection. It differs, however, in the fact that it is a *single-outlet, single-use* special-purpose circuit, designed to serve such 115-volt appliances as dishwasher, food waste disposal unit, or small room air conditioner.

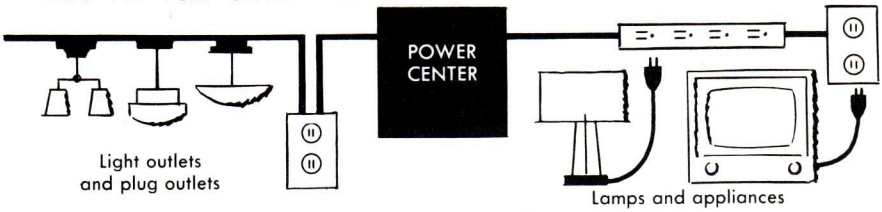
In the 230-volt classification, all three circuit types are single-outlet specific-purpose circuits, designed to serve ranges, clothes dryers, large air conditioners and so on. They differ only in size of wire, protective device and resultant capacity. These three types of circuits are wired with No. 6, No. 10 and No. 12 wire; their fuse or breaker ratings are respectively 50, 30 and 20 amperes; and their 230-volt capacities are respectively 11,500, 6900 and 4600 watts.

CIRCUIT TYPES AND TYPICAL USES

20A—115 VOLT APPLIANCE CIRCUITS

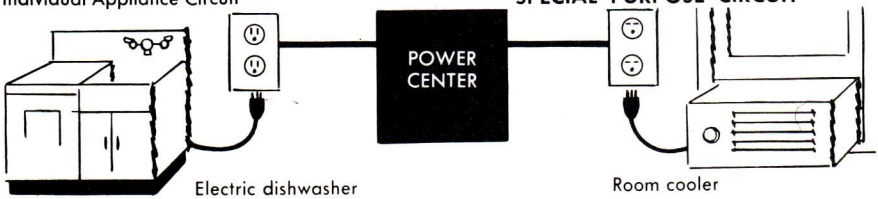


20A—115 VOLT GENERAL PURPOSE CIRCUITS

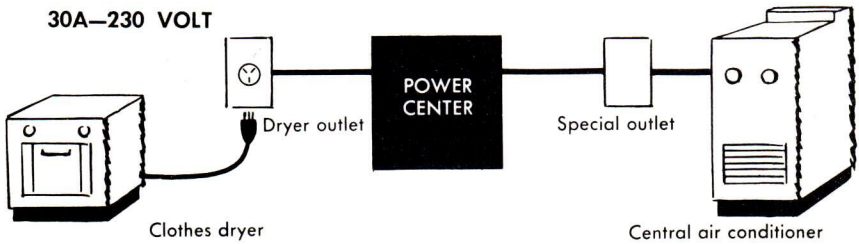


20A—115 VOLT
Individual Appliance Circuit

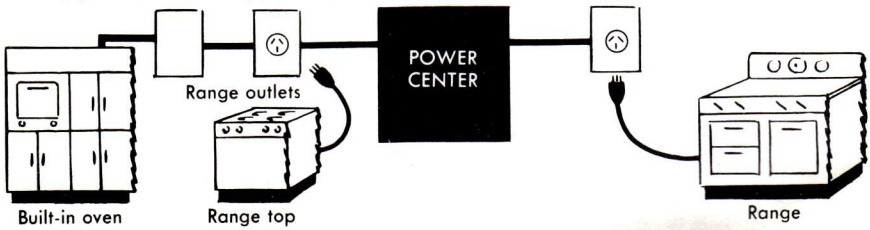
20A—230 VOLT
SPECIAL PURPOSE CIRCUIT



30A—230 VOLT



50A—230 VOLT COOKING CIRCUITS



NOTE: Some appliance models may require larger circuits than those indicated — check mfgr's. rating.

LOAD and CIRCUIT CHART for RESIDENTIAL ELECTRIC SYSTEMS

	Typical Connected Watts	Volts	Wires	Circuit Breaker or Fuse	Outlets on Circuit	Outlet	Notes
				KITCHEN			
RANGE	12000	120/240	3 #6	50A.	1	Special Purpose	Use of more than one outlet is not recommended.
OVEN (Built in)	4500	120/240	3 #10	30A.	1	Special Purpose	May be direct connected.
RANGE TOP	6000	120/240	3 #10	30A.	1	Special Purpose	May be direct connected.
RANGE TOP	3300	120/240	3 #12	20A.	1	Special Purpose	May be direct connected.
DISHWASHER	1200	120	2 #12	20A.	1	Parallel Grounding	These appliances may be direct connected on a single circuit. Grounded receptacles required, otherwise.
WASTE DISPOSER	300	120	2 #12	20A.	1	Parallel Grounding	These appliances may be direct connected on a single circuit. Grounded receptacles required, otherwise.
BROILER	1500	120	2 #12	20A.	1 or more	Parallel Grounding Parallel	Heavy duty appliances regularly used at one location should have a separate circuit. Only one such unit should be attached to a single circuit at the same time.
FRYER	1300	120	2 #12	20A.	1 or more	Parallel Grounding Parallel	Heavy duty appliances regularly used at one location should have a separate circuit. Only one such unit should be attached to a single circuit at the same time.
COFFEEMAKER	1000	120	2 #12	20A.	1 or more	Parallel Grounding Parallel	Heavy duty appliances regularly used at one location should have a separate circuit. Only one such unit should be attached to a single circuit at the same time.
REFRIGERATOR	300	120	2 #12	20A.	1 or more	Parallel Grounding Parallel	Separate circuit serving only refrigerator and freezer is recommended.
FREEZER	350	120	2 #12	20A.	1 or more	Parallel Grounding Parallel	Separate circuit serving only refrigerator and freezer is recommended.
				LAUNDRY			
WASHING MACHINE	1200	120	2 #12	20A.	1 or more	Parallel Grounding	Grounding type receptacle required. Separate circuit is recommended.
DRYER	5000	120/240	3 #10	30A.	1	Special Purpose	Appliance may be direct connected — must be grounded.

IRONER	1650	120	2 #12	20A.	1 or more	Parallel Grounding	
HAND IRON	1000	120	2 #12	20A.	1 or more	Parallel	Consider possible use in other locations.
WATER HEATER	3000					Special Purpose	Consult utility company for load requirements.
				LIVING AREAS			
WORKSHOP	1500	120	2 #12	20A.	1 or more	Parallel Grounding	Separate circuit recommended.
PORTABLE HEATER	1300	120	2 #12	20A.	1	Parallel	Should not be connected to circuit serving other heavy duty loads.
TELEVISION	300	120	2 #12	20A.	1 or more	Parallel	Should not be connected to circuit serving appliances.
PORTABLE LIGHTING	1200	120	2 #12	20A.	1 or more	Parallel	Provide one circuit for each 500 sq. ft. Divided receptacle may be switch controlled.
				FIXED UTILITIES			
FIXED LIGHTING	1200	120	2 #12	20A.	1 or more		Provide at least one circuit for each 1200 watts of fixed lighting.
AIR CONDITIONER ¾ hp	1200	120	2 #12	20A.	1	Parallel Grounding	Consider 4 kw 3-wire circuits to all window or console type air conditioners. Outlets may then be adapted to individual 120- or 240-volt machines. Connection to general purpose or appliance circuits is not recommended.
CENTRAL AIR CONDITIONER	5000	240				Special Purpose	Consult manufacturer for recommended connections.
HEAT PUMP	*14000	240				Special Purpose	Consult manufacturer for recommended connections.
SUMP PUMP	300	120	2 #12	20A.	1 or more	Parallel Grounding	May be direct connected.
HEATING PLANT	600	120	2 #12	20A.	1		Direct connected. Some local codes require separate circuit.
FIXED BATHROOM HEATER	1500	120	2 #12	20A.	1		Direct connected.
ATTIC FAN	300	120	2 #12	20A.	1 or more	Parallel Grounding	May be direct connected. Individual circuit is recommended.

*Maximum connected load (range varies from 6000 to 14000 depending on season).

SOURCE McGRAW-HILL PUBLISHING CO.

Number of Circuits Required

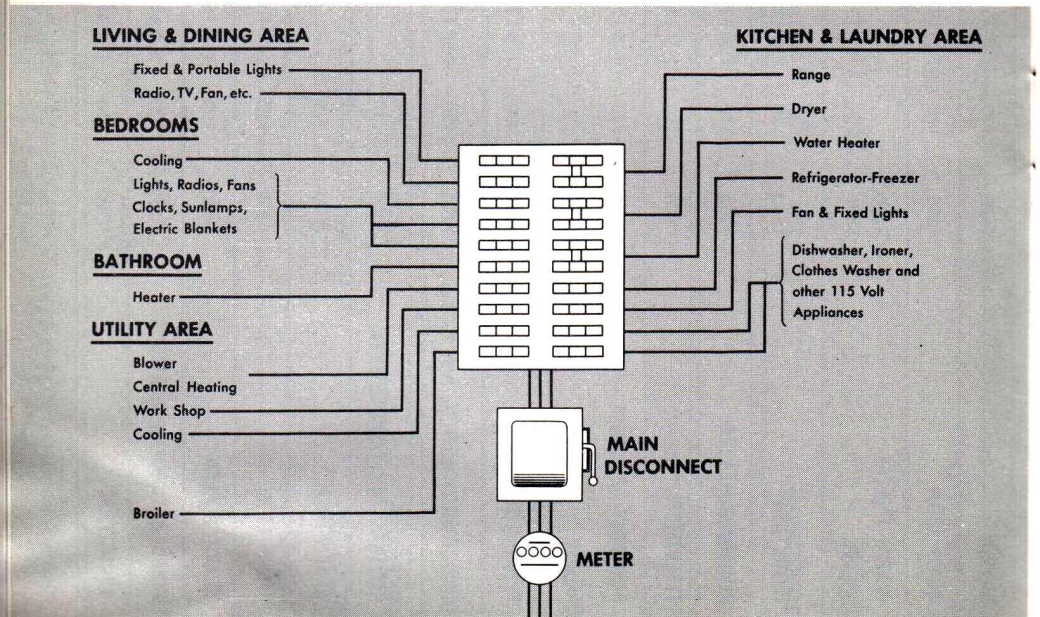
In a completely electrified kitchen and laundry combination area, it would not be unusual to find five separate single-outlet circuits serving a range, broiler, water heater, refrigerator-freezer, and dryer. A sixth circuit would then be required to serve fixed lights and an exhaust fan, while two appliance circuits would be necessary to provide sufficient capacity to serve a dishwasher, ironer, clothes washer, toaster, radio, food mixer, hand iron, coffee maker and similar 115-volt appliances in this area. So, with the appliances and services mentioned, 8 circuits would be required to serve this section of the home.

In the utility area an additional 3 circuits could be used to advantage; the first one serving a blower and central heating unit, the second one serving a summer cooling unit, and the third circuit serving such loads as general lighting, work-shop motors, a soldering iron or the like.

Three more circuits might also be used advantageously in the living-dining area, front entranceway, terrace and for exterior lighting units. For example, two circuits could be used to serve both fixed (valance) and portable lights, a radio, television set, circulating fan, etc. Then, if central heating or cooling was not installed, was insufficient, or was not required for the entire house at the moment, local comfort could be obtained by operating a heating or cooling unit from the third circuit in this area.

Finally, three circuits could be used to advantage in the bedroom-bathroom section of the home; two circuits serving all lights, radios, fans, clocks, sunlamps, electric blankets and the like, while the third circuit could be used to serve built-in bathroom heaters, or a room air conditioning unit, etc.

In the instance just cited, the wiring system calls for 17 circuits. This is *considerably* more than most homes have today yet it represents a wiring plan on the *conservative* side. When we consider that the average home owner of 1970 will use three times more current than we do today, it is apparent that less-extensive systems won't provide "housepower" for modern living 5, 10 or 15 years hence.



CHAPTER IV

SERVICE ENTRANCE DESIGN AND INSTALLATION

The service entrance is actually the focal point of electrical adequacy in the home, ultimately limiting the total energy which may be used. Its design must be based on careful analysis of such factors as: number and types of electrical appliances and devices already on the system; possible and probable types of electrical utilization devices which might be added in the near future; trends toward use of more than one unit of a particular device; and the interrelation of these factors.

The following definitions are given here to eliminate confusion in the discussion. The terms are frequently misused—and used interchangeably—causing unnecessary misunderstanding.

According to the National Electrical Code, the definition of a "service" is "The conductors and equipment for delivering energy from the electricity supply system to the wiring system of the premises served." Other definitions given in the code include the following:

Service conductors—That portion of the supply conductors which extends from the street main or duct or from transformers to the service equipment of the premises served. For overhead conductors, this includes the conductors between the last pole or other aerial support and the service equipment.

Service drop—That portion of overhead service conductors between the last pole or other aerial support and the first point of attachment to the building.

Service-entrance conductors—That portion of service conductors between the terminals of service equipment and a point outside the building, clear of building walls, where joined by tap or splice to the service drop or to street mains or other source of supply.

Where service equipment is located outside the building walls, there may be no service-entrance conductors, or they may be entirely outside the building.

Service equipment—The necessary equipment, usually consisting of circuit-breaker or switch and fuses, and their accessories, located near point of entrance of supply conductors to a building and intended to constitute the main control and means of cutoff for the supply to that building.

Service raceway—The rigid metal conduit, electrical metallic tubing, or other raceway, that encloses service-entrance conductors.

Service entrance cable—Service entrance conductors made up in the form of a cable.

Electricity should serve the individual habits of the family. The designer of the electrical system must take this into account and apply realistic demand factors. Choice of service entrance equipment requires consideration of the number of automatically-controlled appliances and the working schedule of the housewife (simultaneous operation of range, clothes washer, dryer and ironer). By far, the most common method of computing residential service entrance capacity is that provided in Article 220 of the code. It gives definite and reasonable results. However, it is based on safety considerations and may not provide the adequacy, flexibility and convenience of performance desired by the homeowner. For this reason, a service entrance calculation which includes all of the "better living" provisions of load-matched circuits should be used.

CALCULATING A LOAD-MATCHED SERVICE

Calculation of a load-matched service entrance is a straightforward procedure. To determine the size of service entrance conductors, appropriate demand factors are applied to branch circuit load conditions. Conductor sizes are based on the use of a three-wire, single-phase, 115/230 volt supply from the utility, which is a standard requirement for all load-matched wiring systems. In those cases where a three-phase supply offers more advantages, the size of the service entrance conductor is determined on the basis of the service voltage. The sequence of the procedure is as follows:

1. Calculate the lighting load—in watts—by allowing one 20 amp circuit for each 500 square feet of floor space in the house (excluding porches, etc.)

Note: The lighting load could also be calculated by multiplying the square feet of floor area by 4 watts per square foot.

2. Add the total circuit capacity—in watts—allowed for small appliances in the kitchen, dining room, pantry, laundry and utility areas. To

TYPICAL SERVICE ENTRANCE SCHEDULES FOR VARIOUS LEVELS OF UTILIZATION—115/230 volts, 3-wire

Nominal Rating	Maximum Capacity	Main Switch	Main Control Center Units	Size of Service Wire	Size of Conduit	Utilization Circuits
100A	24,000 watts	100A Sw. or 100A Cir. Bkr.	2-50A 1-20A (Water Heater)	2—No. 2 1—No. 4	1¼"	General Purpose Electric Cooking Electric Laundry Water Heater Air Conditioning
150A	36,000 watts	200A Sw. (150A Fuses) or 150A Cir. Bkr.	3-50A 1-20A (Water Heater)	2—No. 2/0 1—No. 2	2"	General Purpose Electric Cooking Electric Laundry Air Conditioning Water Heater Electric Heating (Small Homes)
200A	48,000 watts	200A Sw. (200A Fuses) or 200A Cir. Bkr.	4-50A 1-20A (Water Heater)	2—No. 4/0 1—No. 2/0	2"	General Purpose Electric Cooking Electric Laundry Air Conditioning Water Heater Electric Heating (Temperate Climate)

SAMPLE SERVICE ENTRANCE CALCULATION

For a 1500 sq. ft. home with electric range, electric water heater and electric home laundry

LIGHTING AND GENERAL PURPOSE LOAD:

1500 sq. ft. x 4 watts/sq. ft. . . . . 6000 watts

SMALL APPLIANCE LOAD:

Number of appliance circuits included in branch circuit layout — 4

4 x 2000 watts/circ. . . . . 8000 watts

total 14000 watts

take 3000 at 100% . . . . . 3000 watts

and the remainder of 11000 at 35% . . . 3850 watts

RANGE DEMAND LOAD: . . . . . 8000 watts

FIXED APPLIANCE LOAD:

Water heater	3000 watts
Clothes dryer	4500 watts
Clothes washer	500 watts
Ironer	1650 watts
9650 watts at 100%	9650 watts

Total watts of service capacity: 24500 watts

Required current carrying capacity of service entrance conductors (at 115/230 volts, 3 wire, single-phase):

$$\frac{24500}{230} = 106.5 \text{ amperes}$$

Service entrance conductors must be: No. 1's Type R in 1½" Conduit
or No. 1's Type TW in 1½" Conduit
or No. 2's Type RH in 1¼" Conduit

This service entrance can be described as a 25 kw service, the value obtained by multiplying the current rating of the service entrance by the voltage between the two ungrounded conductors (230 volts). A wide range of possible service entrance arrangements could be used to carry out the design set forth in this typical calculation. If a main disconnect switch is not required by local regulations, six or less circuit breakers can be used as protective subdivisions as set forth in Section 2351 a. of the National Electrical Code. If a main disconnect switch were required in this particular service entrance, either a 200-amp switch fused at 110-amps or, because the calculation contains spare capacity, a 100-amp switch fused at 100-amp or a 100-amp circuit breaker may be used as the main disconnect.

get this total, take the number of 20-amp small appliance circuits selected in branch circuit design and multiply by 2000 watts.

3. Take 3000 watts of the sum of 1 and 2 at 100% demand.

4. Add to this 35% (demand) of the remainder.

5. The sum of 3 and 4 is the capacity which must be provided in the service entrance for lighting and small appliances.

6. Add 8000 watts for an electric range (not over 12kw rating). If a combination of built-in oven and range top(s) is used, Table 29, Chapter 10 of the National Electrical Code should be consulted to get the proper demand load.

7. Add together the rated watts of all fixed appliances.

8. Get the total of: lighting and small appliance demand, electric range demand load, and 100% of the sum of fixed appliance ratings in watts. (Inasmuch as heating and cooling will not be applied simultaneously, use only the higher of the two load values in this step.)

9. Divide this total by 230 (for 115/230-volt, 3-wire service) to get the required ampere rating of the service conductors.

Use of this procedure for determining the size of conductors provides a load-matched service entrance based on calculation and modern branch circuit design. In actual practice, it is often possible to determine every branch circuit required and to lay out the circuiting before calculating the service entrance. In such cases, the above procedure can be modified by using actual design circuit capacities and then applying the appropriate demand factors shown above.

When a wiring system is being planned for a new house, both the builder and electrical contractor should give careful consideration to all of the advantages of a full load-matched wiring system with provision for all anticipated loads. And whenever the owner of a house is known before the electrical system is installed, he should be consulted on design of circuiting and types of loads.

RATINGS OF SERVICE ENTRANCES

As a guide to selection, the following three sizes of service entrances are listed:

100 A—General purpose circuits, electric cooking, water heater, electric laundry.

150 A—General purpose circuits, electric cooking, water heater, electric laundry, air conditioning, and electric heating (small homes).

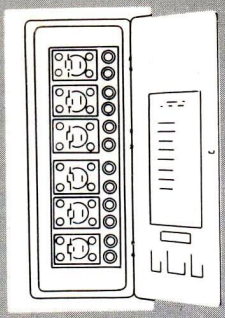
200 A—General purpose circuits, electric cooking, water heater, electric laundry, air conditioning and electric home heating.

POWER CENTERS

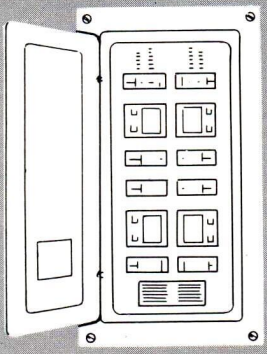
In recent years, there have been substantial developments in service entrance equipments and residential panelboards, which have, in turn, greatly influenced wiring system layout. Almost any desired circuit array can be quickly assembled from inexpensive mass-produced components in standardized cabinets. There has been marked improvement in appearance and most residential devices can be installed flush in the wall.

Installation can be made conspicuously in the kitchen, laundry, utility room or front hall where they are readily accessible and close to the loads they serve. They need not be hidden away in the basement, garage or back hallway.

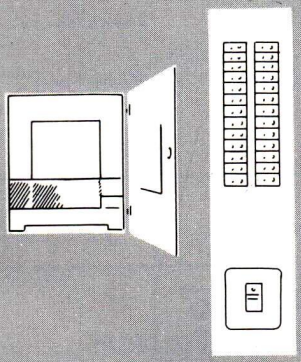
Location of the service entrance equipment is determined by the point of conductor entrance or meter loca-



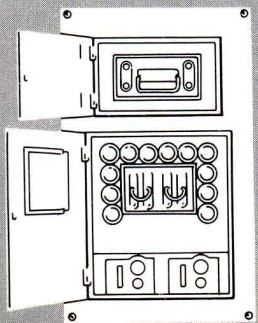
Enclosure contains six pullout-type, 2-pole fused switches to serve such loads as: range, water heater, dryer, etc. One switch is disconnect feeding twelve plug fuse branch circuits on right side.



A 16-circuit, split-bus circuit breaker panelboard for service entrance provides control for eight single-pole, and three double-pole circuits without a main. A 100-amp main supplies the panel.



A large service entrance panelboard is fed by 3-phase supply in 3½-inch conduit. On right is a 42-circuit branch CB panel fed by a 200-amp, 2-pole main CB. At left, a 100-amp, 3-pole CB feeds a 5-hp heat pump unit; a 60-amp, 2-pole CB feeds a range.



SE panelboard has a 100-amp main switch, a 60-amp range switch, a 30-amp dryer disconnect and, at the bottom of the panel, two 30-amp, 2-pole, 2-plug fuse toggle switches to use with single or double element water heater. Twelve plug fuse circuits are provided.

tion—usually a corner of the house. Sub-feed load centers supplied from the service entrance equipment, can be located in the kitchen, utility room, front hall or closet.

The code permits up to six circuits to be served directly from the service entrance conductors. Multiple mains can be conveniently arranged to serve heavy-duty appliance circuits—range, dryer, water heater—and feeders to branch circuit distribution panels at power centers. Typical equipments provide for up to six double-pole fused switches or circuit breakers (or 12 single poles operated by six handles) on a main bus. A separate bus with a group of branch circuits in the same enclosure is fed from one of the mains.

CIRCUIT SCHEDULE FOR TYPICAL POWER CENTER SERVING BUILT-IN COOKING APPLIANCES

Load		Circuit Capacity	Circuit
Built-in oven	Cir. 1-2	30-amp	3-wire No. 10
Range top (2-burner)	Cir. 3-4	20-amp	3-wire No. 12
Range top (2-burner)	Cir. 5-6	20-amp	3-wire No. 12
Receptacles, split (2)	Cir. 7-8	20-amp	3-wire No. 12
Receptacles (2)	Cir. 9	20-amp	2-wire No. 12
Vent fan			
Clock outlet			
Dishwasher	Cir. 10	20-amp	2-wire No. 12
Disposal unit			
Refrigerator	Cir. 11	20-amp	2-wire No. 12
Freezer			
Spare	Cir. 12	.....	2-wire .....

CALCULATION OF LOAD FOR BUILT-IN COOKING APPLIANCES

(From N. E. Code Table 29, Demand Loads for Household Electric Appliances and Other Household Cooking Appliances Over 1¾ kw Rating.)

Two 2-Burner Tops, One Oven

Two 2-Burner Range Tops at 3300 watts nameplate rating each

6600 watts at 75% (Col. B Table 29) 4950

1 Oven at 4000 watts nameplate rating

4000 watts at 80% (Col. C Table 29) 3200

Total range demand 8150

A typical installation would provide the following circuits:

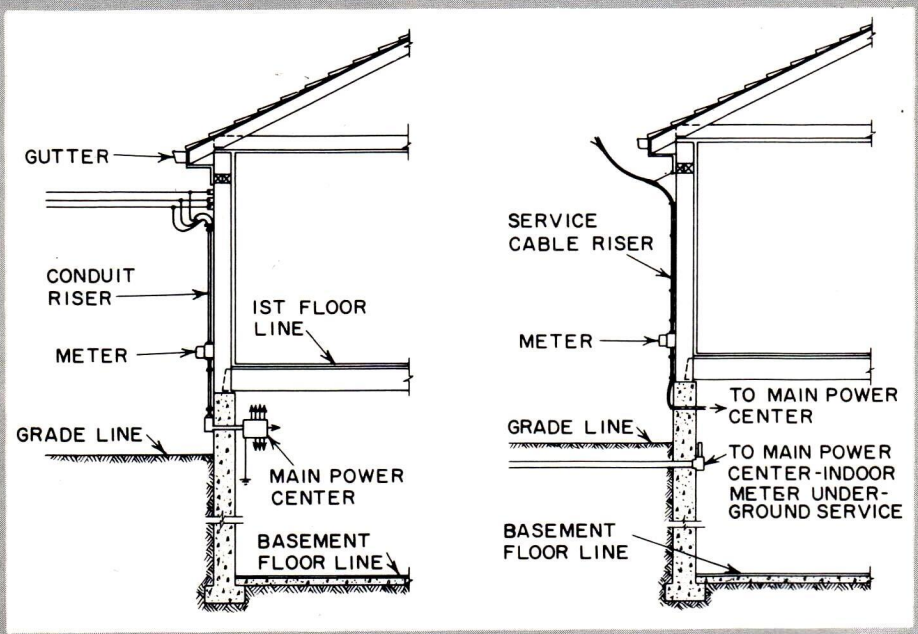
50-amp range
30-amp dryer
20-amp water heater
40-amp air conditioner
40-amp kitchen panel
40-amp lighting panel

When power centers are located flush in living areas, it is important that provisions be made for access to the spares for future use. A 1-inch empty conduit, tubing or flex is extended to the basement or attic terminating in a 4-11/16 inch box with blank cover.

Electric heating and central plant-type electric cooling loads are usually fed from a separate panelboard served by one of the mains. The design of the wiring system for a central type heating and cooling system is governed by the rating and application of the heating equipment. The system is a known electric load, consequently relatively accurate circuit and feeder capacity design is entirely practical.

The rapidly developing trend toward built-in cooking appliances is easily and economically served by kitchen power centers. The conventional range circuit can become the

SERVICE INSTALLATIONS FOR STANDARD TYPE HOMES



feeder to the panel. Circuits to cooking appliances and other appliance outlets are short and efficient. Since home runs are little longer than runs between outlets, isolating circuits and single outlet circuits can be provided for little more than the cost of the panelboard overcurrent device.

For a typical all-electric kitchen with built-in cooking appliances, a standard 12-circuit (12 poles) panel provides a practical power center. The circuit schedule should have cooking appliances on individual circuits, automatic appliances on isolating circuits and portable appliance outlets on three appliance circuits.

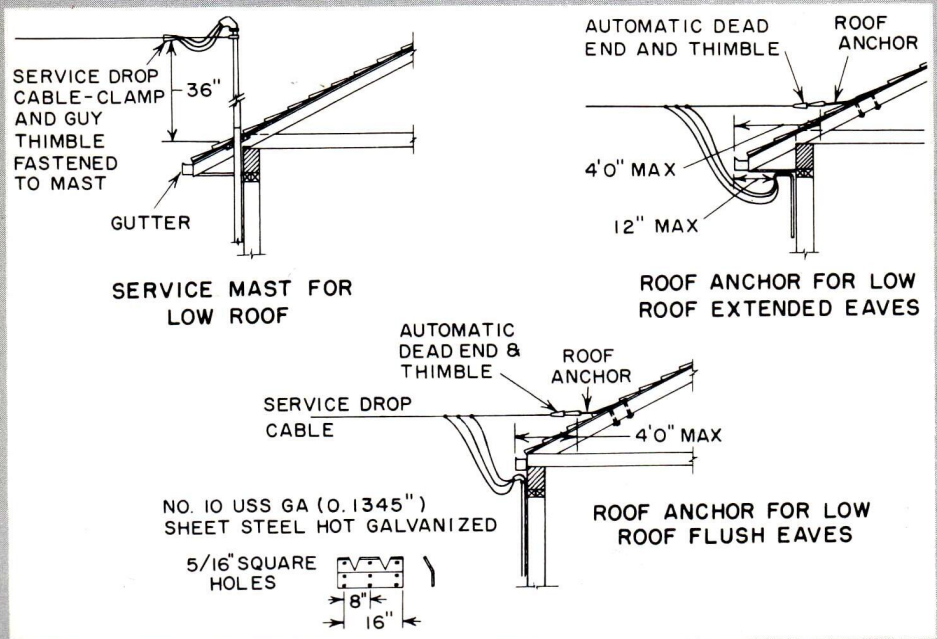
For such a panel, the demand load should be calculated to get the size of the required feeder. This may be done as follows:

Small appliance load	1500 watts
Dishwasher	1200 watts
Disposal unit	300 watts
Refrigerator	300 watts
Freezer	300 watts
Cooking appliances	8000 watts (approx.)

(Actual value computed from table 29 Chapter 10 of the code).

Totalling up these figures and dividing by 230 volts gives the required current carrying capacity of the feeder to the panel.

SERVICE INSTALLATIONS FOR RANCH TYPE HOMES



CHAPTER V

CONTROL OF RESIDENTIAL ELECTRICAL EQUIPMENT

Lights and utilization devices play an important part—but not the only part—in helping homeowners live better electrically. New switches, and the devices that control electrical equipment and lighting, are constantly being developed and improved.

Consider, for example, the ordinary wall switch for controlling a light. Modern design is so advanced that only the slightest movement of the hand is required to actuate the switching mechanism. Properly installed, it is noiseless, 100% shockproof, can be wired and mounted more rapidly, and it will operate efficiently for a considerably longer period of time.

Then there are automatic controls —heating system regulators, clock thermostats that maintain two preset levels of temperature during waking and sleeping hours; aquastats to keep water heated to the prescribed temperature, pressure control switches to regulate steam pressure . . . and the many electrically operated or actuated safety controls to reduce risk of damage from fire and explosion.

Automatic controls enable the washing machine to go through its complete cycle of processes, including damp drying, without any human attendance. Automatic cycle control today is a feature in any appliance performing more than one basic activity.

Automatic control developments forthcoming are almost beyond the imagination of the present-day homeowner. The photo-electric cell and the radio have already indicated what may be expected in the home . . . such as:

. . . kitchen shelves that open and lower themselves to shoulder level at the wave of a hand;

. . . garage doors that can be opened without the driver leaving the car;

. . . driveway lights that turn on as a car enters the grounds or leaves the garage.

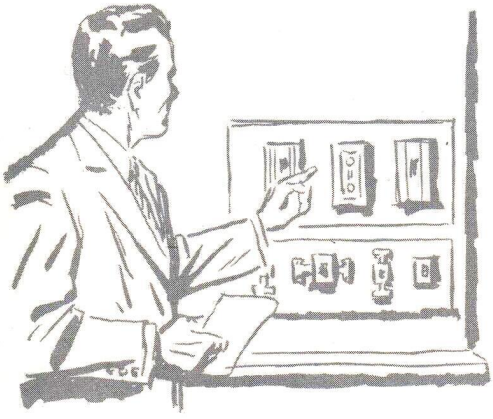
These automatic switching systems illustrate the potentialities of control equipment. They also indicate a trend toward increasing emphasis on convenience through well-planned switching.

Planning the switching arrangement

Laying out a residential switching system for greatest convenience and safety is a cooperative planning operation. It demands an intimate knowledge of the day-to-day living habits of the family (Does mother often forget to turn off the iron?) which only the homeowner himself

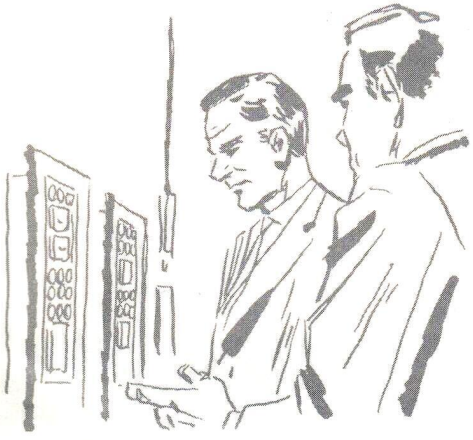
can furnish. Similarly, it requires a close acquaintance with all types of available control equipment and their range of application. The homeowner and the technician should go through the house (or study the plans) room by room. Each piece of electrical equipment should be considered separately as to the most desirable means of controlling it. This process takes time, but it pays off in the form of a better system.

Actual formation of the switch layout involves three steps:



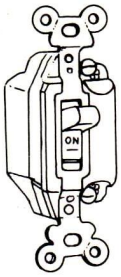
1. Analysis of switching requirements for every item of electrical equipment in each area of the house, inside and out. Selection of exact location for switch outlets.

2. Selection of types of switches to be installed. This step also involves choice of flush plate style and finish.



3. Discussion and decision on possible use of special control equipment such as dimmers, combination outlets and various types of automatic controls.

The pages following cover each of these three steps in precise detail. The important types of control equipment generally employed in residential systems are described. These are the keys to convenient and efficient control in the modern electrical home.



Snap Switch—Toggle style is present standard. Illuminated handles and silent types are available.

Door Switch—Closes circuit, turns on light as door is opened.

Planning the Switching Arrangement

Step One—Layout

Homeowners are seldom able to designate their exact switching requirements. The electrical designer must make suggestions as they go through the house (or its floor plans), telling what is needed and why.

In laying out the switching for the modern home, there are basic rules to follow:

1. Basic lighting units in each room must be controlled from every entranceway to that area. In the living room, where table and floor lamps are now the most common basic light source, switches should control split-wired base receptacles.
2. Lights on stairways should have switches at top and bottom for each light.
3. Bedroom ceiling lights should be controlled from bedside as well as from entrance.
4. Outside lights should be controllable from garage or terrace to provide well-lighted, safe walk from either or both of these areas.
5. Basement lights should be controlled by switch and pilot combination outside the door at the head of the stairs so that if lights are left on, the pilot light will be visible even if the cellar door is closed.
6. Door switches, or even wall switches are greatly preferred over pull chain switches for controlling closet lights.

Following is a check list of individual items of electrical equipment which may require switch control.

Entrance—illuminated house number sign; post lantern; outside receptacles for seasonal displays; garage light; floodlights and walk lights; terrace receptacles.

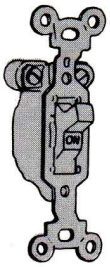
Living Room—valance lights; mantle outlet; ornamental brackets; porch lights and porch receptacle outlets.

Dining Room—valance lights; ornamental units; appliance receptacle outlet.

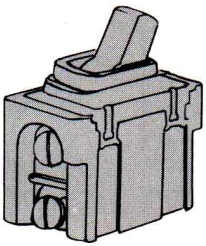
Kitchen—local lights at sink and breakfast bar; portable appliance outlets; exhaust fan.

Bathroom—electric heater; mirror cabinet lights and receptacle outlet; shower light (control outside stall); portable appliance outlet; nightlight outlet.

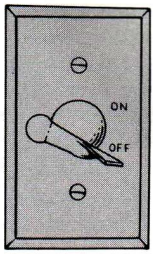
Halls—nightlight; general lighting switches near each bedroom door.



Mercury Switch—Silent operation; available "T" rated in all types.



Interchangeable Switch—Up to three switches and/or receptacles used in one gang box.



Weatherproof Switch—For open porches, terraces.

Bedroom—bedside switches for general, ornamental and reading lights; mirror lights and vanity tables require local switches.

Laundry—portable appliance outlet (with pilot).

Basement—emergency disconnects for heating and cooling equipment, workbench outlets, storage room.

Step Two—Selecting Control Equipment

The first decision involved in selecting control equipment is the choice between conventional line-voltage switching and the more modern, low-voltage remote control wiring system. The low-voltage method offers design possibilities for convenience and flexibility in the switching layout which are not easily obtained with line-voltage equipment. The unit cost of low-voltage control decreases as the number of units in the system increases. Therefore the low-voltage system is extremely well-suited, from the standpoint of economy as well as performance, for control installations designed to achieve the highest degree of enjoyment and convenience from the household electrical equipment.

Advantages of Low Voltage Wiring

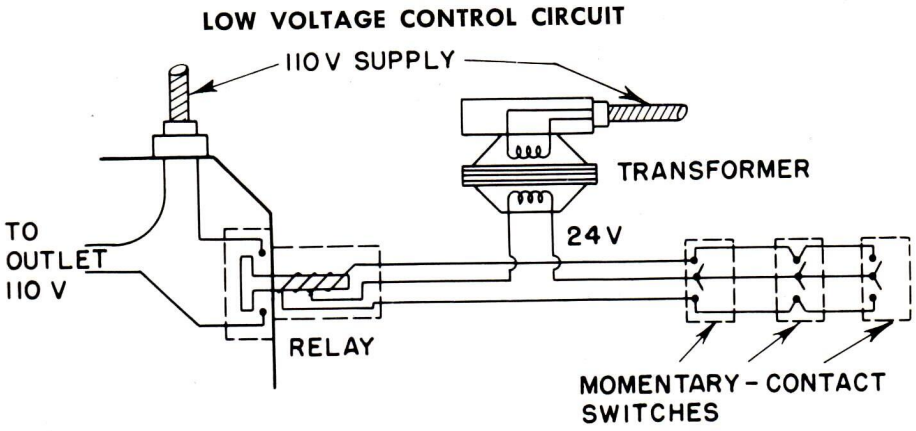
This system has been designed specifically to provide the convenience, comfort and safety that are an essential part of modern electrical living. Each component of the system contributes added benefits to the L-V control method.

The relay isolates all switches from 115-volt circuits, thus improving the *Safety* rating of the system. It permits long runs of inexpensive wiring, encouraging the use of *Remote Control* switching in locations far removed from the utilization equipment.

Low voltage switching allows any number of switches to be used on each control circuit. This feature makes *Multi-point Control* an economic practicality.

Master selector switches and motor-driven master switches afford *Escape from Routine* inconveniences of day-to-day living. Here are a few services that can be obtained from a bedside master switch:

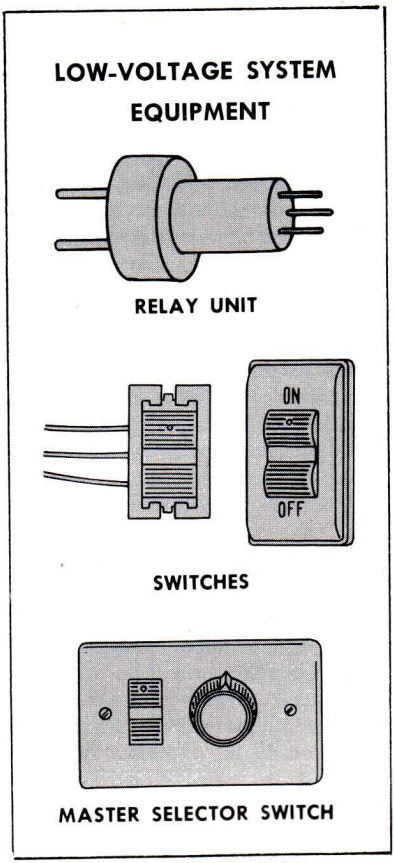
1. Turn on kitchen coffeemaker before arising;



2. Turn on bathroom electric heater so the room will be warm enough though central heat is not yet up;
3. Turn off all lights in the house before retiring without making a round of the entire house;
4. At home alone, the housewife feels more secure if she can turn on houselights and outside floodlights without leaving her bed;
5. Turn bedroom lights on and off from bed;
6. On cold mornings, local electric units for preheating auto and melting snow from driveway can be turned on from the bedroom before arising;
7. Turn on nightlights in hall and children's rooms.

The small, inexpensive wire used with this system can be easily installed—new switches can be added and existing switches moved with a minimum of cutting and patching. Low voltage control is ideal for house modernization jobs where existing control is operated at line voltage.

Because these characteristics are unique to low-voltage control, the system will undoubtedly become increasingly popular among home-



owners and builders. Electrical men should prepare for this development by familiarizing themselves with the techniques of designing and installing an L-V system and, even more important, by taking every opportunity to promote its acceptance and use in residential wiring.

The various manufacturers of low-voltage control devices have prepared excellent manuals for the layout and installation of L-V equipment. These handbooks include precise details of the operations which are essential to success in the use of the system. Following "Step Three" of this section, basic installation information is given, but only to an extent that will acquaint the non-installer with the methods involved; for proper guidance in mounting and connecting the equipment, the installer should refer to the manufacturer's manual.

Line Voltage Switching Equipment Several types and styles of line voltage switches are available for residential wiring. The homeowner should be encouraged to select the devices for his own home. This practice increases his understanding and appreciation of the service which the electrical technician is performing for him and of the benefits that he will obtain from a superior wiring system.

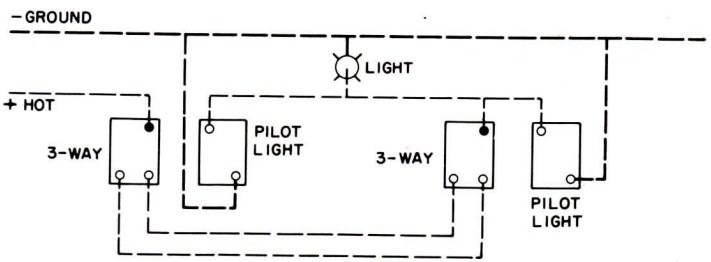
The basic control device in the residential wiring system is the flush *toggle switch*. It is available in three types: the standard mechanical; the mercury; and the silent mechanical. All these come with brown or ivory handles and in the ratings and styles—single-pole, double-pole, three-way and four-way—used in the home.

For rewiring existing outlet boxes, *interchangeable unit devices* permit the mounting of up to three devices in a single gang box. Besides a complete line of switches, interchangeable units include receptacles, pilot and nightlights, and radio outlets.

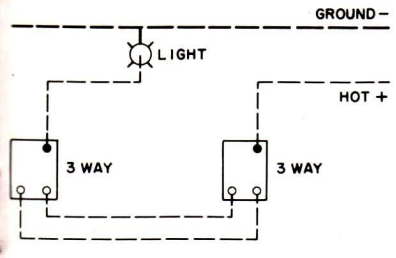
Switch Plates As with switch devices, the consumer should be urged to select a top grade line. Inexpensive plastic plates tend to crack or break more often than top line plates. Inexpensive metallic plates have thinner finishes and lose their polish more rapidly. The best line will give long, trouble-free service.

Step Three—Covering Special Controls

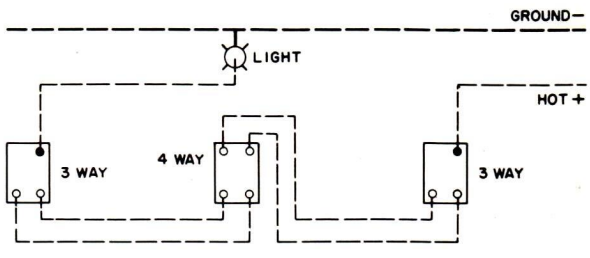
When the basic switching layout has been completed and basic types of control equipment selected (Steps One and Two), the customer should be briefed on various special control devices that may be used to obtain



THREE-WAY SWITCHES WITH WARNING LIGHTS



3—WAY
CONTROL FROM TWO LOCATIONS



4—WAY
CONTROL FROM THREE OR MORE LOCATIONS
FOR EACH ADDITIONAL CONTROL ADD A 4—WAY SWITCH

additional service from the electrical equipment in his home. Following is a brief list of the more popular automatic controls employed in modern residential systems.

Dimmers enable the homeowner to regulate the intensity of light in local areas such as the living room, dining room, master bedroom and porch. Residential dimming equipment is usually located in the room which it controls. The unit is mounted flush into the wall with only the face plate and control dial exposed. Most dimmers for home use are rated at 300 watts, but they may be banked if the lighting load in the room exceeds this amount.

Time Switches are frequently used in the home to provide automatic control of exterior lighting equipment such as post lanterns, "protective" yard lighting, and Christmas displays. Many makes of switches are available with astronomic dials to adjust the time the circuit is closed so it conforms with changing hour of sunset and sunrise. Programming devices may also be included to permit omission of switch operation on any number of days in the week.

Garage Door Operators have found wide favor among homeowners. This equipment permits the owner to open or close the garage doors from his car. Two types are in use. The radio unit involves a transmitter in the car and a receiver in the garage. When the signal is picked up by the receiver, it actuates a relay that closes the control circuit and starts the driving motor. Limit switches cut off the driving motor as the door reaches the end of its track. The less expensive system is similar except that it is controlled by a pushbutton mounted on a post at the driver's side of the garage approach.

Photo-Electric Cells have almost no limit on the possible use in the home. The cell is sensitive to changes in light intensity, thus it may be used to turn equipment on or off as natural light fades at the end of the day. Connected with an auxiliary unit delivering a steady beam of light, it can be used as an invisible guardian to turn on lights or to sound an alarm when the light beam is broken. These basic applications may be adapted to perform any number of services in the home.

Thermostats have other applications than to control the central cooling and heating system. They can be used to start exhaust fans when kitchen or even house temperature reaches a pre-set degree. With an outside bulb and a timing device they can operate a small portable electric heater in the car so that the engine is warmed before it is started on winter mornings.

Several manufacturers have devel-

oped small thermostatic devices for use as home fire detectors.

Magnetic Throwover Switches have been found valuable where an emergency power plant is installed in the home.

Preparation and Installation

Every effort should be made to convey the exact details of the installation to the electricians who will do the work. For a line voltage switching system, this can be accomplished with only an electrical plan and a brief specification covering mounting height of switches and locations and wiring instructions for special control equipment.

Installation of a low-voltage control system requires detailed drawings of control circuits unless the installer is experienced in this type of work. If the relays are to be mounted in outlet boxes of the equipment they control, the layout of L-V conductors is relatively simple. With relays located in central gang boxes the routing of wires is rather complicated and should be closely supervised during the job.

Preparation of a material list for switching equipment requires consideration of code provisions governing switches:

National Electrical Code states that switches located in damp areas or outside of a building must be provided with a weatherproof enclosure or a cabinet. The Code recommends that boxes of non-conductive material be used for damp locations when nonmetallic sheathed cable is used.

N.E.C. puts the following restrictions on switching equipment:

a. For non-inductive loads other than tungsten filament lamps, switches shall have ampere rating not less than the rating of the load.

b. Tungsten filament (incandescent) lamp loads require "T" rated switches. Certain exceptions are made for residential systems, but the advisibility of using "T" switches should outweigh any slight saving to be derived from using any other type.

c. Inductive loads (particularly fluorescent units) require switches rated at twice the ampere rating of the load unless the device is specifically approved for this purpose.

Most manufacturers' catalogs list the above information along with the descriptions of the various types of devices they produce. These listings should be consulted in ordering control devices.

CHAPTER VI

MODERN WIRING MATERIALS

Wires and Cables

Since the end of World War II many new types of wires and cables have been developed. Information concerning these improvements has been directed to the industry through the media of advertising and in catalogs. Some confusion has resulted from the excessive use of trade names and the overlapping designations given to wire types by manufacturers, Underwriters' Laboratories and other electrical industry agencies. The following chart covers the principal types used in residential wiring, code provisions on use and other data on application. Cables, as the term is here used, are assemblies of two or more insulated conductors enclosed in a protective wrapping of metal and/or other material such as rubber, neoprene, plastic, treated paper, or braided cotton.

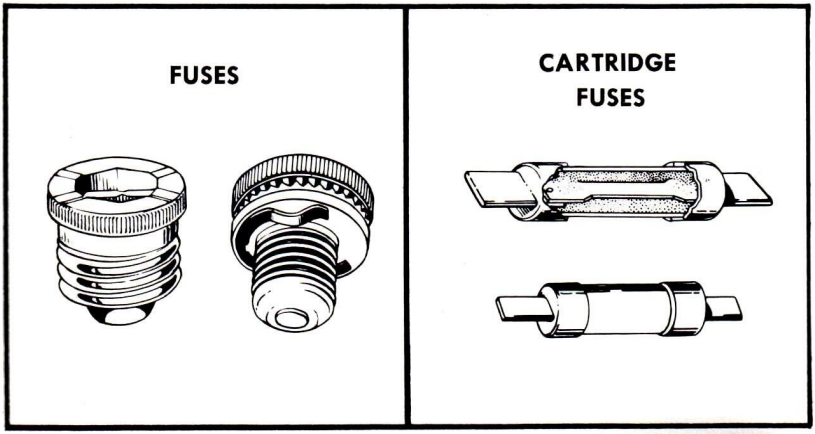
Protective Devices

The choice between circuit breakers and fuses is usually based on these factors: lower cost of fuses versus superior convenience of the resettable circuit breaker.

Fuses—Distribution and load centers for residential use generally employ plug fuses for protecting single-pole circuits rated at 30 amps or less. For two-pole circuits and those above 30 amps, pull-out units accommodating cartridge fuses are employed.

Plug fuses are available in three basic styles:

A. Tamper-resistant (type S) — permanent screw-in adapter



WIRES AND CABLES

TYPE	DESCRIPTION	APPLICATIONS
R	Single conductor with rubber insulation and braided cotton covering.	General wiring where moisture is not present. Temperature rating 60 C.
RH	Similar to type R except rubber insulation has higher resistivity to heat.	General wiring where moisture is not present; has higher current carrying capacity than type R. Temperature rating is 75 C.
NMC (Moisture and corrosion-resistant)	Same as NM except with corrosion-resistant outer covering of impregnated braid or other material.	Same as NM except may be embedded in plaster or run in chase provided protection is afforded from nails by $\frac{1}{16}$-in. steel plate. Neither NM or NMC may be embedded in concrete or used for service entrances.
RH-RW	Rubber insulation has heat and moisture resistant properties of types RH and RW.	For damp locations, the temperature rating and current-carrying capacity of type RW are used; otherwise the higher ratings of type RH apply.
RHW	Similar to RH-RW.	Similar to type RH-RW except ratings of type RH apply for all installations.
TW	Polyvinyl chloride insulation is highly resistant to moisture heat and corrosion. Rated at 60 C. Current capacity of type R.	General use and damp areas. While allowable conduit occupancy is the same as type R in new installations, the smaller dimensions of type TW are used in calculating the number of conductors allowed in existing conduit on rewiring; this permits substantially higher capacities than other types of wire.
NM (non-metallic sheathed cable)	Rubber or Thermoplastic insulated conductors, with or without separate grounding conductor, covered by heavy paper wrapping and a strong braid.	Interior wiring—exposed or concealed in dry locations. Not allowed where exposed to corrosive fumes or vapors, nor embedded in masonry, concrete, fill or plaster. Use non-metallic boxes or surface devices unless grounding wire is in NM cable.

WIRES AND CABLES — CONTINUED

TYPE	DESCRIPTION	APPLICATIONS
UF (Underground Feeder)	Thermoplastic Insulated and jacketed conductors in single or multiple conductor styles.	Single conductor for direct burial feeders (all legs in one trench) Multi-conductor UF may be used as NMC.
AC and ACT (Called Armored cable)	Rubber (AC) or thermoplastic (ACT) insulated conductors encased in wound and interlocked steel armor; bonding strip under armor.	All interior wiring except in moist areas embedded in masonry, or in block walls below grade.
SE Style U (Unarmored)	2 Rubber-insulated conductors and bare neutral strands (usually spiralled around insulated conductors) covered by protective layers of rubber tape and impregnated braid. Also available with insulated neutral.	For service entrances; interior wiring of range, dryer, or water-heater providing heater is not fed by uninsulated conductor. With insulated neutral, use is governed by code provisions on NMC.
ACL	Same as AC except with lead sheath.	Moist areas, underground, and embedded in concrete.
SE Style A (Armored)	Same as Style U except with bonded steel tape under outer layer of rubber tape. Interlocked armor (not bonded) sometimes used in place of steel tape.	Same as Style U except interior applications governed by code provisions on armored cable. For interior use, tape or armor must be grounded.
SD (Service Drop)	Similar to Se Style U.	Primarily for drop from pole to service mast.
USE (Style RR)	Rubber-insulated conductors encased in neoprene jacket single or multiple conductor. (All RR conductors are not UL approved for USE applications.)	Underground service entrances and runs in conduit or direct burial. Also used for aerial runs.
MI (Mineral Insulated — Metal Sheathed)	Conductors insulated by highly compressed refractory mineral material and enclosed in a liquid — and gas-tight flexible metallic tube.	All normal residential applications including underground, embedded in concrete, and service entrance. Approved connectors required.
RW	Similar to type R except with moisture resistant rubber insulation.	In all areas including damp conditions. Temperature rating and current carrying capacity same as type R.

will accommodate only type S fuses within the 0 to 15 amp or the 16 to 30 range, thus restricting possibility of overfusing. Type S fuses have time-delay feature.

B. Standard Zinc-link—householder should be cautioned against using 25 or 30-amp fuses on 15 or 20 ampere circuits. Starting surges in appliance circuit can occasionally cause a fuse to blow.

C. Time-delay—affords temporary allowances for small overloads involved in motor-starting, but instant break on dead shorts.

Cartridge fuses are also made in three types within the range of rating employed in residential systems. In addition to the instant-break and the time-delay types (whose characteristics are similar to comparable plug fuses described above), there is also available a renewable fuse. This type is not recommended for house wiring systems since it is possible to replace the fuse link with a heavy copper strap, thus removing all protection and creating a definite hazard.

Circuit Breakers for residential applications usually combine thermal and magnetic operating features. Overload protection is obtained from a bimetallic element which opens the circuit if the current exceeds a value corresponding to the rated capacity of the breaker. The magnetic element consists basically of a solenoid type of arrangement that opens the circuit in the event of a short circuit current.

CHAPTER VII

ELECTRICAL UTILIZATION SYSTEMS IN THE HOME

Technological advances have resulted in a wide array of *new* electrical products and devices. They include indoor and outdoor lighting (fluorescent and built-in types not generally familiar to homeowners), signal and communications systems, electrical space heating and air conditioning and ventilation.

How to light a home

Presented here are recommendations for lighting the various rooms and areas of a home, and suggestions for many lighting treatments . . . some of which are not yet in general use.

Living Room—Good lighting and good living go hand in hand. Since the living room is the focal point of more activities than any other room in the home, good lighting with maximum flexibility is of paramount importance in this room.

Three types of lighting should be installed in the living room:

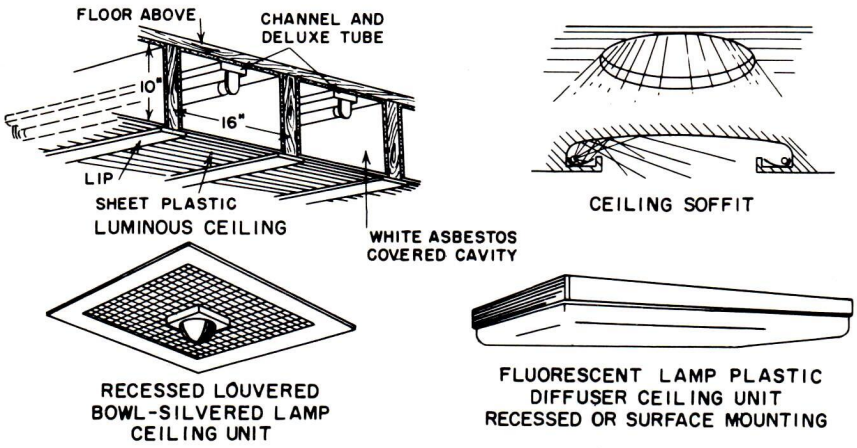
1. General illumination throughout the entire room.
2. Local lighting at each furniture grouping, or at each area where some specific activity (sewing, reading, card playing, etc.) is carried on.
3. Decorative lighting.

Individuality in lighting for each home can be achieved through selection of specific lighting techniques for each of the three types of lighting needed. An extensive range of techniques exists for each type. Also there are practically unlimited possibilities for the use of lighting for decoration, for safety, for utility and to suit the whims and fancies of the most exacting homeowner.

In the living room, particularly, maximum use should be made of multiple switching and dimmer controls for all lighting. They are, in fact, part of the lighting design and should be so treated. Each lighting element, such as a cove, valance, individual floor and table lamps, mantle light, recessed down lights and pinhole spots, lighted ornaments, etc., should be individually controlled by wall switch or local switch at the equipment. Circuiting should be arranged so that one or more lighting elements can be dimmer controlled. In this way, lighting effects to suit exacting requirements (even moods) can be produced easily and simply. As an alternate to dimmer control, a minimum of two switches should be used for the lighting in every room where multiple light sources are employed. This provides for some variations in the lighting effects.

Dining Area—For the past few years there has been a trend in house design to combination living-dining rooms, where the dining area becomes

METHODS FOR GENERAL LIGHTING



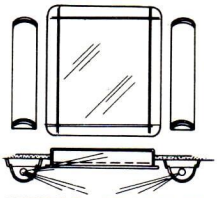
a part of the living room. This area is for formal dining usually, while a dinette is provided for informal meals. This practice still exists, but there is now a trend back to larger houses and individual dining rooms. With minor variations the lighting problem is basically the same for either arrangement.

For combination living-dining rooms, the lighting system and equipment in the dining area should harmonize with that of the living area. Lighting effects in the two areas should complement each other. Lighting needs include: 1) general illumination; 2) accent lighting for the table; and 3) supplementary and decorative lighting.

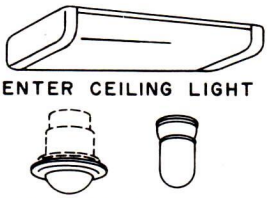
General illumination is most easily provided with a two-circuit dining fixture. This fixture type is also equipped with a center spotlight arrangement to highlight the table. Two wall switches are required—one for the spotlight—one for the other bulbs. Very effective accent lighting for the table is achieved by using recessed spotlights in the ceiling. Two units are generally required. Some optical-lens downlights come equipped with shutters to adjust the beam size to the exact shape of the table. Whenever downlighting systems of any kind are used, general lighting should be provided by valances, cornices, coves, or portable lamps such as torcheres or buffet lamps.

Supplementary and decorative lighting could include any of a variety of perimeter lighting techniques. For example, a wall-recessed aquarium made luminous with concealed lighting could be used. Or a glass block false window might be translighted in color with color lamps connected to a motorized dimmer circuit. Built-in corner or wall china closets and cabinets add a decorative touch to the dining area when softly illuminated. Wall-mounted plastic or glass ornaments, whether trans-lighted by incandescent, or edge-lighted by fluorescent, or made to fluoresce with "black light" are other typical and suggested "light for decoration" treatments.

LIGHTING FOR THE BATHROOM

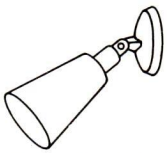


MIRROR BRACKET LIGHTS



CENTER CEILING LIGHT

VAPOR-PROOF FOR SHOWER STALL



RS SUNLAMP BRACKET

For full-length mirrors, shielded fluorescent fixtures extending the full length of the mirror, one on each side, provide good lighting for that purpose. Surface-mounted fixtures do a better lighting job but a neater appearance results when the fixtures are recessed. A ceiling-recessed, large-area luminous panel installed directly in front of the mirror might be used as an alternate, but is not quite as effective. It is better used to supplement the sidelights.

Bathrooms—A very small bathroom or powder room may be lighted by the two mirror wallbrackets (centered 60″ above the floor) which should be used in any size bathroom. These brackets should use 24-inch fluorescent lamps in deluxe warm or cool color, or 60-watt incandescent bulbs behind diffusing glass measuring four to five inches in width.

For medium and large size bathrooms, a center ceiling light is needed to provide general illumination. This should be over the front edge of the lavatory to provide extra light for hair grooming and to supplement the usual two wall brackets at the mirror. A vaportight ceiling light should be installed over the tub or shower stall.

An added convenience in the bathroom is a sunlamp. A pair of reflector housings for typical RS sunlamps, which may also be used for infrared lamps, should be installed above and to the sides of the mirror, so that both sides of the face will be tanned evenly. In very large bathrooms, it may be desirable to provide a mat-covered table above which a bank of two to four sunlamps could be placed.

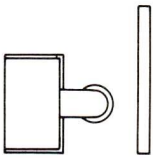
Kitchen—Lighting requirements in the kitchen are for general lighting over the entire room area, and for local lighting over all individual critical work areas.

A good large-size ceiling fixture centered in the room provides general lighting to brighten the room and puts light into wall and base cabinets and drawers. Ceiling-mounted fluorescent fixtures of the type shown in this book are the most effective, but a number of good fixture designs using inside frosted and silvered-bowl incandescent bulbs do a good job and are low in cost. If circline fluorescent fixtures are desired, the new three-lamp units using deluxe lamps provide plenty of light and good color rendition. The single-lamp circline unit is not satisfactory for a kitchen fixture.

Large luminous panels lighted with deluxe fluorescent lamps create an interesting "skylight" appearance and provide excellent general lighting in the more deluxe kitchen. This idea may even be expanded to make the entire ceiling luminous. Design of such a luminous ceiling is quite specialized and it is desirable to consult with the equipment manufacturer's engineering department before attempting installation.

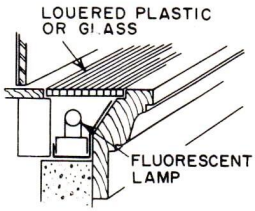
LIGHTING DEVICES FOR SPECIAL APPLICATIONS

CEILING UNIT

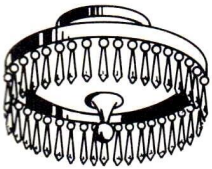


BED LIGHT

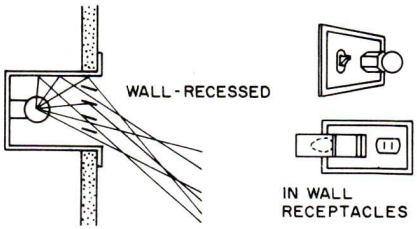
FOR THE BEDROOM



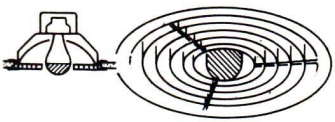
ILLUMINATED
MANTLE



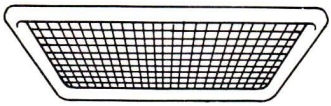
HALL OR FOYER



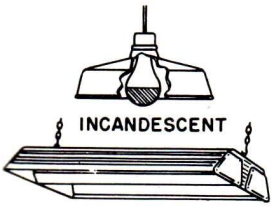
NIGHT LIGHTS



RECESSED INCANDESCENT



COVERED FLUORESCENT
RECESSED

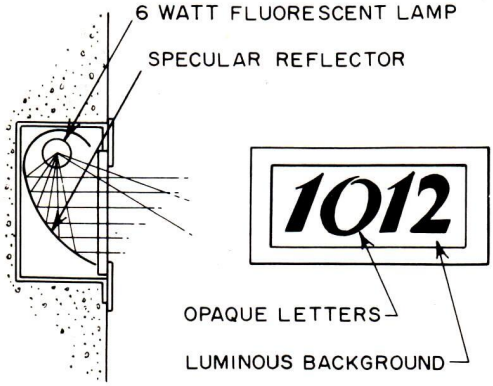


FLUORESCENT

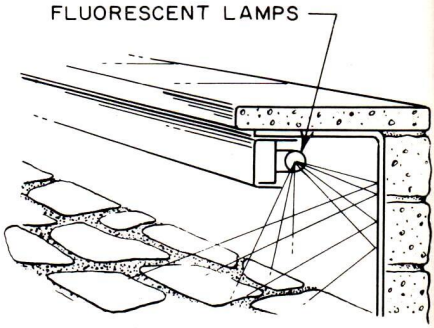
FIXED ADJUSTABLE

RECESSED HOUSINGS FOR
REFLECTOR LAMPS

OUTDOOR LIGHTING DEVICES



LIGHTED HOUSE NUMBER



TERRACE LIGHTING

Direct lighting recessed units provide good local lighting for work areas, such as food preparation, cooking and dishwashing centers. Undercabinet lighting provides excellent local light on work counters. Luminous clocks, and lights within cabinets which turn on when the doors are opened, are innovations available to homeowners who may desire them.

When it is impracticable to provide both general lighting of low intensity and local lighting of higher intensity, a good alternate is to provide a high intensity of 60 to 75 footcandles in illumination over the entire room area, using any of the typical lighting techniques suitable for general lighting.

Den or study—Indirect lighting, supplemented by direct lighting over the desk and reading area provides a high quality of comfortable lighting in this room.

Entrance Foyer—A decorative type close-to-ceiling or pendant luminaire in the entrance hall gives an impression of cordial warmth and graciousness. It should conform in design to the architectural style of the house. Recessed units with oval, round, or square plastic diffusers, or low brightness luminous ceiling, or other modern recessed type lighting units, are suitable for contemporary homes, as are many of the modern design "fixtures".

Hallways—Close-to-ceiling type decorative units are suitable for low-ceilinged halls, and suspended luminaires are appropriate for halls with high ceilings.

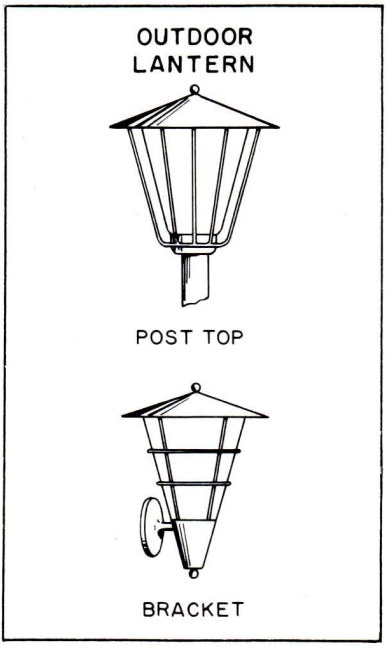
Recreation room—Any of a wide range of architectural and built-in lighting techniques are suitable for the recreation room, depending on the activities for which this room was designed. Here is an area where the homeowner may well express his own individuality in lighting and decoration. The lighting man should merely guide him in the selection of lighting techniques which will insure adequacy and comfort.

Continuous lamp wall lighting with both upward and downward components of illumination, is appropriate for recreation rooms, provided ceiling is white or light in color and side walls are of a light finish. Recessed

troffers, coffers, built-in louvered incandescent luminaires, and large-area luminous panels are all appropriate. Lighted ornaments, built-in luminous wall niches, etc., all add interest and enterprising homeowners will think of many more.

Laundry—Industrial type fluorescent or incandescent reflector units provide ease-of-seeing lighting for the laundry and utility areas. Reflectors should be shielded to eliminate glare from the lamps, and units should be installed 48 inches above laundry equipment, ironers or ironing board, work benches, etc.

Garage—In a single car garage two 100 watt white bulb incandescent lamps are recommended, mounted in a ceiling socket, one on each side of the car. They should be located about six feet back from the front bumper. In a two-car garage a third outlet and lamp on the wall between the two doors is desirable.



Closets—A 60-watt white lamp in a socket mounted over the door on the inside closet wall provides light for the entire closet. This lamp should be controlled by an automatic door switch. An ozone lamp in suitable metal fixture and mounted on the closet wall helps keep the closet "outdoor" fresh, and prevents stale, musty odors.

OUTDOOR LIGHTING

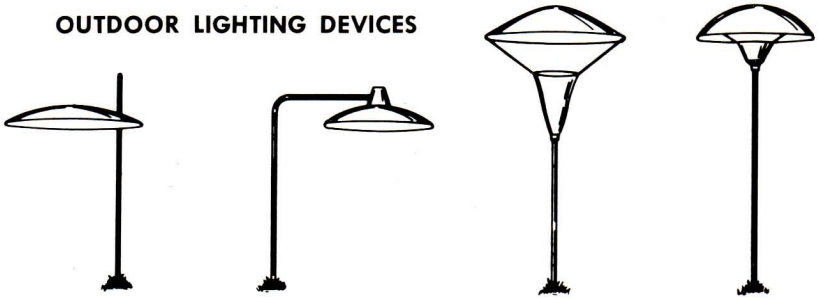
Outdoor lighting is attracting an ever increasing number of people, and is being planned for in more and more homes. With it grows the trend to unify yards and grounds with the home for greater use and beauty. And now, outdoor lighting makes it possible to maintain these qualities, and create beautiful artistic effects after sundown.

Outdoor lighting for utility—Outdoor lighting has been in use for utility applications, in a limited way, for many years. This use is now expanding to new applications, and to increased use for old applications. Homeowners today plan for more outdoor living and have more time for after dark entertaining and recreation.

Front entrance—Wall brackets, one on each side of the front door, 66 inches above stoop, are the long accepted method of lighting the front entrance for quick, sure seeing and for safety of friends and family against possible accident, and to discourage trespassing.

Other lighting techniques applicable for front entrance lighting include: Post-top lantern, recessed unit under door sill, step lights, fluorescent lamps under ledge of terrace wall, eaves-recessed or surface mounted floodlights, etc. House numbers, recessed into wall at side of door, or

OUTDOOR LIGHTING DEVICES



SIDE– SUSPENDED INDIRECT CENTER-STEM

MUSHROOM TYPE LIGHTING UNITS

STANDARD

POLE

FLOODLIGHTS

over it, or in terrace wall, or on a lawn-located post, can be self-illuminated, and should ideally be kept burning continuously.

Rear entrance—A wall bracket over the rear door, or at latch side, 66 inches above stoop, makes entrance and exit easy and helps prevent accidents. Reflector lamps and floodlights to flood the entire area around the rear entrance with light, may be mounted under eaves, or on an adjoining pole or building.

Garage--A weatherproof bracket over the garage door, preferably of the prismatic glass wide spread light distribution type, lights not only the garage entrance, but also the yard or lawn area adjoining it. This and other lights along walkways should be switch-controlled from both inside the house and at the garage. When garage doors are radio-controlled, or push-button controlled from the garage wall, or from an entrance-way post switch control, the garage and house entrance lights should also be arranged for automatic control by the same device.

Walks and driveways—Lighting along walks and driveways makes their use at night safer against both accidents and prowlers. There are many designs of mushroom and pedestal type units suitable for lighting walks and paths. Also there are post-

type lanterns, floodlights, and pole-mounted street-light type units for lighting roadways and driveways. These lighting devices provide utilitarian light primarily, but by careful placement they can also be made to tie in with a decorative lighting treatment of the lawn and grounds.

Outdoor entertainment and play areas—Enclosed and open-type floodlights, reflector lamps in weatherproof housings, open wire streamers, and pendant or bracket-arm type street lighting luminaires are suitable for lighting recreation and entertainment areas, such as tennis and badminton courts, outdoor volley ball and basketball courts. They are also excellent for rock garden illumination, barbecue pits, shuffleboard courts, ping pong tables, croquet courts, outside area around swimming pools, etc.

Lighting for protection—Lighting units installed for utility, or to provide safety for entry and exit at the house or garage, and for getting around the grounds also provide protection. A minimum arrangement, however, is the installation of reflector lamps or prismatic glass lens units under the eaves of the house, directing light away from the house at all points, and lighting the entire area. Switch control should be provided from the master bedroom, and from the rear hall or inside the rear door.

Lighting for decoration — Vistas out the living room windows can be made most pleasing at night through the use of light and color—the creation of patterns of light and shadow. By means of multiple switching arrangements and dimmer control, the total lighting pattern may be adjusted to changing mood and visual need.

Near the house flower beds and shrubbery may be lighted to create a brightness pattern outside the glass windows and provide natural transition between indoor and outdoor areas. Trees farther out on the lawn can be lighted from below to create interesting highlights and shadows. Underwater lighting in color in swimming pool, or reflection pool, can make these points more interesting by night than by day. And a water fountain lighted in color, with the colored lights controlled by motor-operated dimmer, can be a source of continuing pleasure for guests and family alike. The secret of successful color lighting at a fountain is, first, to create plenty of water spray, to catch and reflect the light, and second to use properly balanced quantities to the different colors of light. Overhead strings of lights, enclosed in Japanese lanterns can also be quite festive, and add to outdoor party gaiety. There are innumerable applications of lighting for decoration, and home owners will devise individual and artistic ones to suit their own outdoor areas, and within their financial means. Such lighting need not be expensive when done on a reasonable scale, but can, of course be as elaborate as the home owner may desire.

OUTDOOR LIGHTING EQUIPMENT

All permanently installed outdoor lighting equipment, including the wiring for it, should be weatherproofed, and properly designed for trouble-free operation in the rain or snow. (Caution: Any non-weatherproof lighting equipment or wiring should be disconnected immediately when it begins to rain, and remain disconnected until all equipment has thoroughly dried following a rain.)

Wiring for outdoor lighting may be either permanent, or temporary. Permanent wiring preferably should be run underground, but may also be run overhead from the eaves of the

house to high poles, or to bracket arms equipped with insulators high up on trees, or buildings. Underground wiring is not only safer, but also maintains a neat appearance. Portable extension cords, preferably of Type S, SJ, SO, ST, SJT or SJO, and specifically designed for outdoor use with suitably molded rubber plugs and sockets, should be used for temporary connections.

There are a wide variety of types of outdoor lighting units now available commercially. These include: mushroom type units in which metal reflectors are supported 27″ to 36″ above the ground on a variety of types, shapes, and sizes of stems; adjustable standards or poles for mounting PAR lamps in adjustable housings and with color roundels, louvers, shields and similar accessories; flush or surface-mounted wall units, with prismatic glass lens refractors, or with metal louvers for shielding; under-water units (large—for swimming pools, etc., small—decorative metal shields attached to lamp bulbs for floating on top of water, as in a lily pond); weatherproof fluorescent strip units for flooding large areas with white or colored light; enclosed floodlights; ornamental shields which stimulate garden objects and hold one or more lamp bulbs; festoons, with lamp sockets spaced at any intervals desired; and many others.

CLIMATE CONTROL

Ventilation

Ventilation today performs an essential and accepted function in the modern residence, thus adding to the comfort of electrical living by providing indoor conditions which contribute to proper rest and relaxation and help lighten household chores. It is generally used in lieu of air conditioning, but may also be used as a supplementary aid. Its primary function is to cool the house, and to get rid of stale air and odors from basement areas, kitchen, bathroom, etc.

Cooling the house is accomplished principally by attic and window fans, and is usually done at night. It is done by drawing large quantities of cool night air into the home and exhausting the hot daytime air accumulated inside. This air movement tends to balance the inside and outside temperatures.

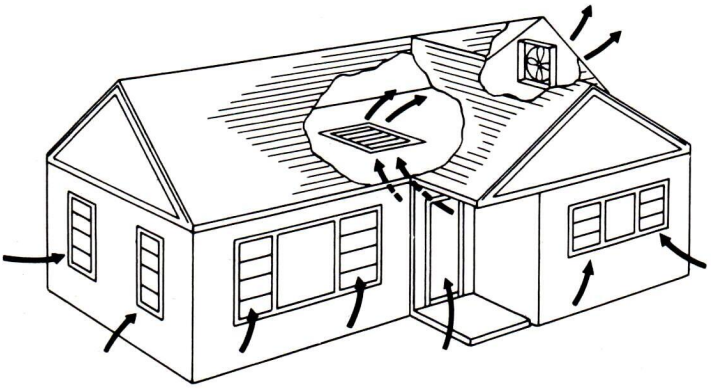
Attic fan installations should be powered by a separate circuit from the main service entrance panel.

Kitchen fans, properly selected and located, insure rapid elimination of cooking odors and heat, and add immeasurably to kitchen climatic comfort. Such fans should be located as near the kitchen range as possible so that fumes and grease vapor will be trapped and dissipated though the air outlet to the outside before they spread within the house.

Fans should be selected of a size to provide an air change every five to ten minutes. Fans should be reasonably quiet in operation, of good quality construction, and equipped with automatic shutters for weather protection when installed in windows or outside walls.

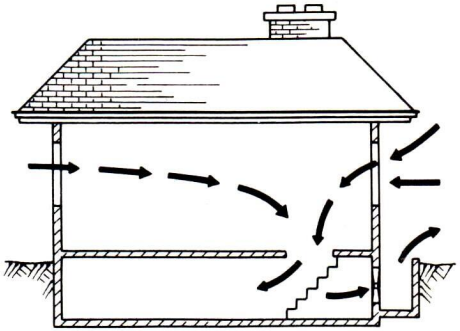
Air filtering

Air filtering by means of electrostatic precipitation is rapidly becoming an important part of planning home heating and cooling systems. Basically, this is a method of filtering extremely fine dust and pollen particles out of the air. The benefits to the user are immediately apparent in terms of cleanliness, particularly in homes near an industrial area. In addition, certain types of allergies due to dust or pollen particles, are considerably relieved when the sufferer has such filtering in his home.



FAN IN ATTIC

Electrostatic precipitation is applied to both room units and central systems although, obviously, the latter is more effective. New, small size, inexpensive power packs have recently been developed, bringing the cost well within range of home installations. In addition, design progress has reached the stage where operating expense and any possible high voltage hazards have been greatly reduced.

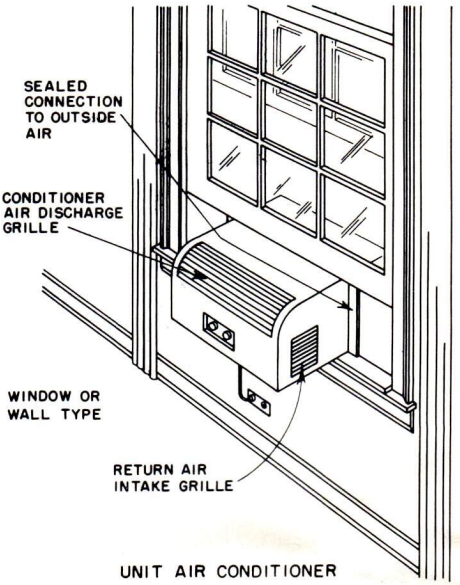


FAN IN BASEMENT

COOLING

Evaporative type coolers are quite common in, but limited to, geographical areas with high summer ambient temperatures and relatively low humidities. The cooling effect is provided by the evaporation of water which results in an increase in indoor humidity.

Room air conditioners, whether window sill or wall installed, are primarily devices for cooling a single room or space and avoid the expense of ductwork, which is of particular significance in existing homes. They do however, pose a wiring problem in that they constitute relatively high loads, particularly on start-up, and thus require special purpose outlets on separate circuits for each location. These units dehumidify as well as cool.



UNIT AIR CONDITIONER

Central type cooling systems provide complete summer air conditioning for an entire building, usually distributing the cooled and dehumidified air through ductwork to each room. In some instances "wet" systems are used in which cool water is circulated to individual cooling coils in each room where an electric fan blows air over these coils and forces it out into the room. Electrical requirements must be determined from the rating of the equipment which usually involves a compressor motor of from 2HP (1000–1500 square feet home) to 10HP (3000 square feet home).

Wiring for Air Conditioning

A special purpose outlet on a separate 3-wire No. 12 circuit, one for each unit air conditioner used, and located at the most likely point of installation, should be installed in each principal living area and in each bedroom.

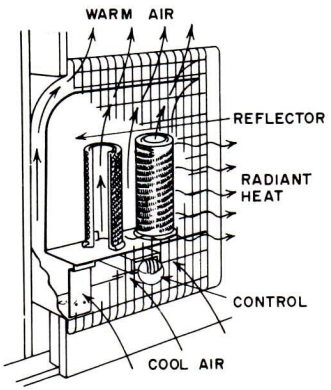
The use of general purpose or appliance circuits to serve air conditioners is *not* recommended. Even smaller units, though they may be rated within the capacity of such circuits, require a large portion of the circuit capacity under continuous duty over long periods of time. During this time the entire circuit and its other outlets are effectively blocked for other uses for which the circuit was designed, intended and installed.

Most unit type air conditioners are connected to the electrical system through a plug and fixed receptacle. Units of ½ ton capacity or less are usually equipped for operation on 120 volts. Units of ¾ ton capacity and larger should be equipped for operation on 240 volts. The metal parts of all air conditioners should be grounded.

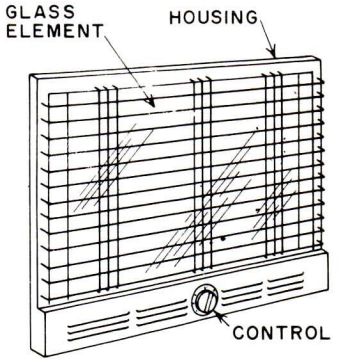
In new homes, when air conditioning is not included in the plans, provision should be made in the wiring system to take care of installation of units by the home owner at a later date. If outlets are to be provided they should be American Standards Association grounding type outlets.

ELECTRIC HEATING

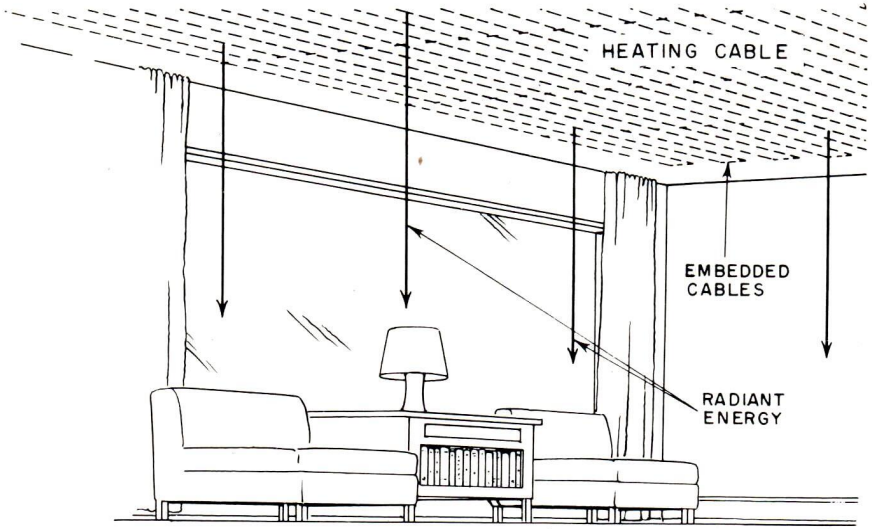
Portable Heaters—Portable type, natural convection heaters are suitable for limited space and limited use heating applications, as are portable type radiant connection portable fan heaters. These units are equipped with cord and plug for connection to electric power receptacles.



WALL PANEL

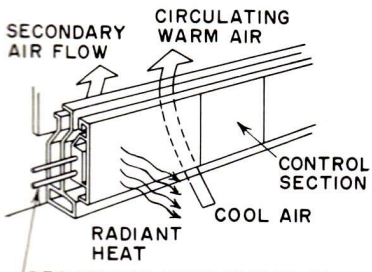


GLASS PANEL

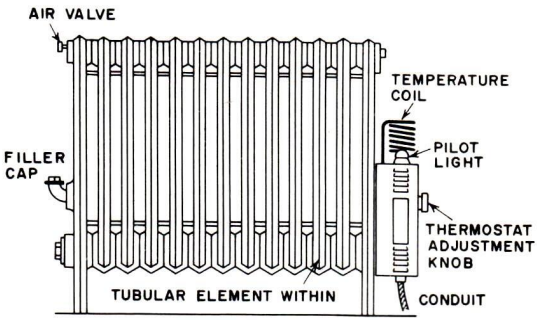


Heating panels—Permanently installed types of resistance heating panels are available in a wide variety of designs, types, and sizes. They include glass panel types for wall or ceiling mounting, conductive rubber panels for ceiling installation, laminated wire panels, resistance wire units, electric steam radiators and electric resistance baseboard heaters for perimeter heating. Whether or not homes are centrally heated, either electrically or otherwise, these built-in electric unit radiant or hot air wall heaters are useful for quickly removing the chill from bathrooms, nurseries, breakfast nooks, bedrooms, and locations where local heating is desirable. They provide fast response, high efficiency, quiet operation, safe construction, low operating cost and automatic temperature control features.

Resistance heating cables—Thermoplastic insulated resistance wires, made up in sets with non-heating leads, provide predetermined heat output. These wires may be installed



ELECTRIC BASEBOARD



ELECTRIC RADIATOR

in ceilings (but not in plaster walls), in concrete slabs, or floors. When installed, it is laid as a flat coil with a specified spacing between turns. This spacing depends on heat loss of the room to be heated, as does the length of cable required and the area of the surface to which the cable is to be applied. Each room should be separately controlled by a thermostat.

Resistance wires can be stapled directly to plaster-board or other surfaces, covered by plaster, placed between ceiling joists and must be backed up by an insulation blanket to direct heat downward, or they may be embedded directly in concrete.

Resistance heating cables provide radiant heat primarily. Some advocates prefer it in the floor, others think it is more effective when placed in the ceiling. It has worked satisfactory in both locations. When installed in the ceiling, it simulates the radiant heating effect of the sun, and thus has a psychological advantage at least.

Controls—Glass heating panels and resistance wire panels for wall mounting normally have built-in thermostatic control. But for ceiling panel installations, resistance heating cable installations in either floor or ceiling, and for central heating units, wall-mounted thermostat control is used.

The electric furnace consists of electric heating elements, a fan, and thermostatic controls. Air is warmed as it passes over the heating coils. Heat output is varied by using a multiple number of heating elements, individually controlled by the thermostats. The electric furnace is, however, less efficient than room resistance heaters, as loss of heat occurs in the air duct system.

Year round electric heating units, such as combinations and heat pumps, will be covered later.

Humidity Control

In most areas of the country, humidity control (i.e. humidification in winter or dehumidification in summer or both) is desirable. The extent to which equipment can provide effective humidity control is largely determined by the house design characteristics (insulation, weatherstripping, double glazing, etc.)

Most warm air type heating plants have available accessory humidifiers for installation within the heating unit and controlled electrically by means of a humidistat located in the living quarters. Low voltage control wiring is standard for these.

Portable electrically operated humidifiers are available, incorporating a water reservoir, spray device and fan. These are of the plug-in variety designed to operate from the standard 115 volt convenience outlet.

Portable, electrically operated dehumidifiers are also available for use in damp areas, particularly basements and utility rooms. These units usually incorporate a $\frac{1}{8}$ or $\frac{1}{6}$ HP refrigerating machine and are designed to plug-in to standard convenience outlets.

YEAR ROUND AIR CONDITIONING

Combustion electric central plant systems are available in many forms and styles, but basically they consist of a standard heating unit and a standard cooling unit enclosed in a single cabinet or in separate but integrally styled enclosures. The electrical requirements are the same as though the individual units were considered separately except for the control circuit which is usually integrated to provide automatic operation of both heating and cooling from a single thermostat.

Individual room air conditioners, either window-sill or wall mounted

RECOMMENDED RATE OF AIR CHANGE

Space or Purpose	*Air Change*
Night Cooling	1 to 1.5 Minutes
Kitchens	2 to 3 "
Basements	5 to 10 "
Bathrooms	2 to 5 "
Dark Rooms	5 "

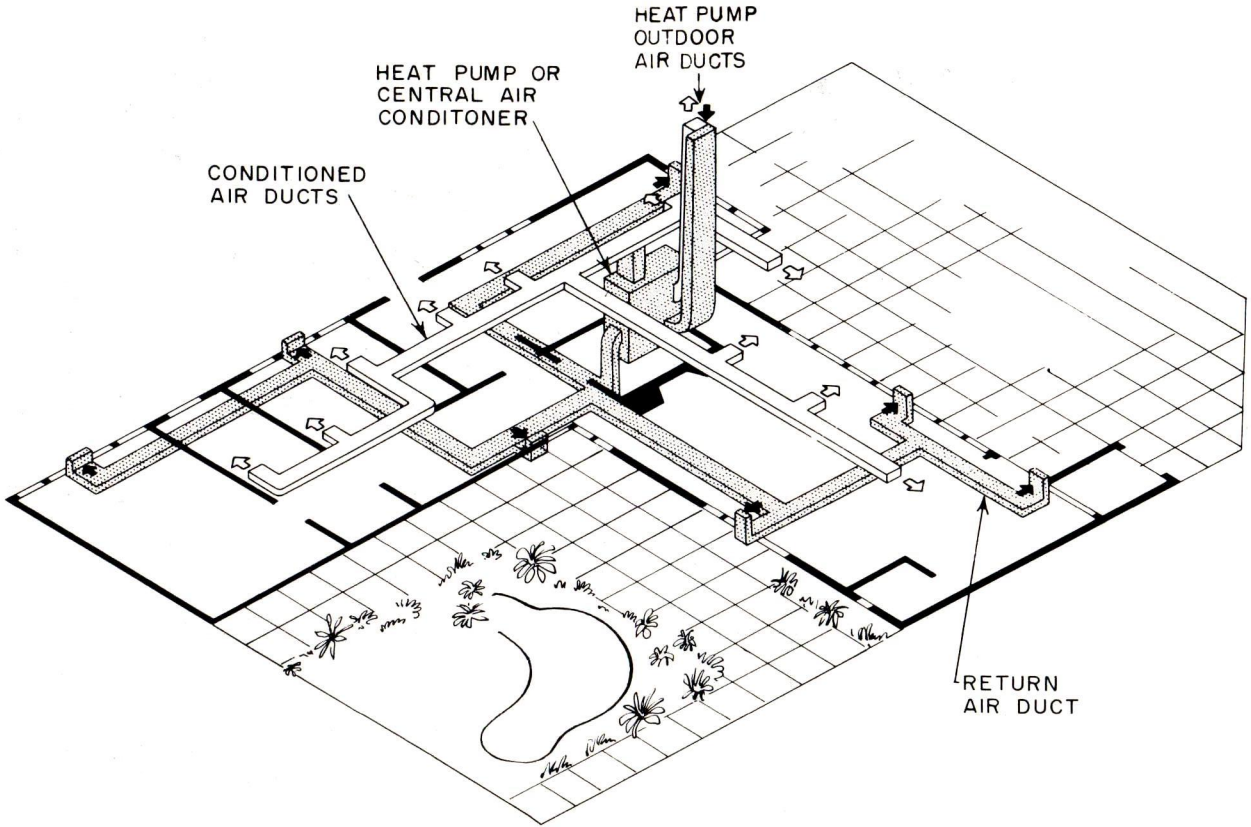
types, are available for year round use. Some utilize the reverse cycle heat pump principle, others incorporate electric resistance heaters to provide the heating function. Electrical requirements are similar to those for units designed for summer air conditioning except that where electric resistance type heaters are used, higher electrical loads can be anticipated and larger capacity individual circuits are required.

The heat pump is a summer air conditioner designed to operate in reverse to provide heating in winter. It is basically a refrigerating machine, and in the same manner as a refrigerator or room air conditioner it extracts heat from one place and moves or "pumps" it to another. The reversal from cooling operation to heating operation is accomplished automatically, under control of the room thermostat, by interchanging the operation of the two coils, or convectors.

In winter the heat pump extracts heat from the outdoor air or from the ground or subsurface water. It actually cools the outdoor air (or the ground or water) even colder than its natural winter temperature and the heat extracted during this process is pumped inside to warm the house.

The heat pump moves approximately three times as much heat as would be obtained if the electric power used to operate it were converted directly into heat by a resistance heater. This 3 to 1 ratio is known as the performance factor of the unit and gives an operating economy which in many areas results in heating costs comparable to and sometimes lower than heating costs with combustible fuels.

Electrically, heat pump applications vary widely, depending on both


HEAT PUMP
OUTDOOR
AIR DUCTS
HEAT PUMP OR
CENTRAL AIR
CONDITONER
CONDITIONED
AIR DUCTS
RETURN
AIR DUCT

climate and house design. In many cases some form of auxiliary or supplementary heat is provided as the most economical means of handling the relatively short periods of extreme cold weather. In many of the larger homes (above 1,500 square feet) 200 amp, 3 wire service will be required to meet the electrical requirements of the heat pump and the balance of the house. For maximum economy this should be carefully planned by a competent electrical contractor.

SIGNAL AND COMMUNICATION SYSTEMS

Signal Systems

Signaling systems can range from the minimum single front door bell, to the more elaborate chimes with multi-point control and audible and visual annunciators in homes with servant accommodations.

Recommended minimum is a chime with front and rear (trade) door operation that will give a different tone or note characteristic for each point of operation. If bells or buzzers are used, each unit should have a different tone to distinguish between front and rear (or side) doors.

The installation of flush loudspeaking telephone equipment at each commonly used exterior entrance, with an interior telephone station in basement, kitchen, and second floor hall (or master bedroom) will save steps and appeal to most housewives.

A flush annunciator may be installed in the kitchen with push button stations in each bedroom, living room, recreation room, porch, etc., especially in large two-story houses. As an alternate, flush intercommunicating telephones may be substituted for the annunciator and push button stations.

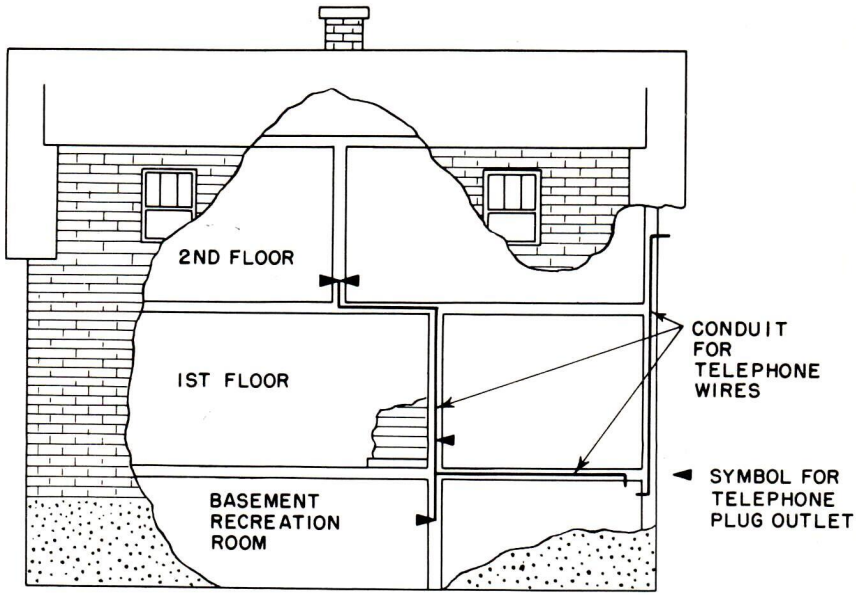
An automatic home fire alarm system is recommended in every home, with detectors in critical areas, especially in the oil burner or furnace area and in the storage space, and other areas not frequently visited by members of the family. Alarm bell and test button should be installed in the master bedroom or similar desirable area. This system should be powered by and operate from a separate and independent transformer.

Communication Systems

Wiring channels for telephone conductors should be planned when a new home is built. Service conduit, interior raceways, outlet boxes and telephone niches should be installed while the home is under construction. This makes possible telephone installations of greatly improved appearance. Outlets may be of the conventional type for permanently connected units, or the jack-plug receptacle for portable telephones, as desired by the resident. Technical assistance is available from the local telephone company, and it should be consulted regarding local service facilities, regulations, and similar matters.

An intercommunicating telephone system affords a highly desirable convenience for the larger home, and manufacturers of the various systems should be consulted for specific features of equipment, installation details, and required wiring.

Multi-station television antennae systems are being installed in homes to provide outlets for operation of one or more TV sets from the same aerial, or moving one set from room to room as occasion demands. Each television outlet should be served from a separate 120 volt circuit of 2 No. 12 wires.



TYPICAL LAYOUT FOR TELEPHONE

CHAPTER VIII

SELLING LOAD-MATCHED WIRING FOR ELECTRICAL LIVING

Long-range, effective selling of load-matched wiring systems depends upon a planned approach to the many factors involved. First, the significance and technical details of modern residential electrical utilization, as presented in this book must be studied and thoroughly understood. Then all of this material which can be used in selling the customer must be reduced to terms, phrases and concepts easily understood by the customer. Finally the contractor or salesman must develop a positive attitude toward his customer.

He must have thorough knowledge of residential wiring. He must know how to get all essential information over to the customer in a clear, understandable way. And he must be honest, direct and uncompromising in talking up the advantages of load-matched wiring.

USE NON-TECHNICAL DESCRIPTIONS

Once the engineering story of residential wiring is fully and clearly understood, the details of various phases of the work can be translated into non-technical language. Customer presentation should be simple and direct, using analogies wherever they serve to clarify a description.

Inasmuch as the most common troubles of electrical systems are frequent blowing of fuses, low voltage and an inadequate number of outlets, the branch circuits represent the best starting point for an explanation of the electrical system.

In explaining the condition of inadequate branch circuiting, the number of existing circuits should be called to the attention of the prospect. Then it should be explained that each circuit can handle so many watts of load. The familiar #14, 2-wire circuit could be described as a 1700-watt circuit, with a quick follow-up account of the effect of overload—such as why the fuse blows when appliances totalling over 1700 watts are simultaneously connected.

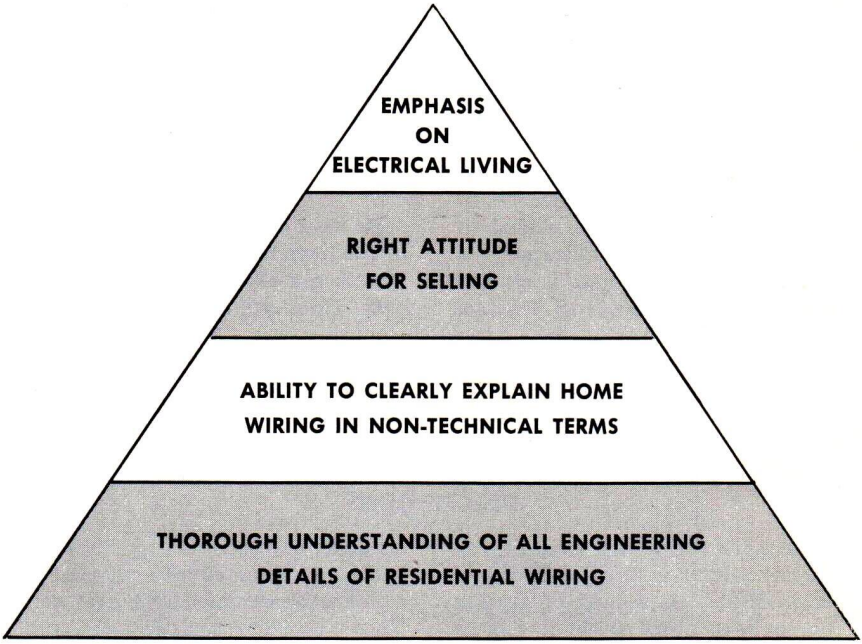
The analogy of water in a big pipe feeding into small pipes and current in the service entrance conductors feeding the branch circuits offers a good basis for explanation.

SELL THE "LIVE BETTER. . . *ELECTRICALLY*" IDEA

One of the most effective techniques for selling modern load-matched wiring is to sell electrical living first. The pleasure and convenience of better electrical living are of prime interest to the public. If a homeowner is sold on living better electrically, sale of the wiring system which will make it all possible becomes much simpler. It is clear that the sale of appliances is the most effective first step to the sale of wiring.

Selling the complete "package" of better electrical living—appliances

SALES



and utilization devices along with a load-matched wiring system necessary to handle them—can be promoted by local advertisements and direct mail campaigns. Advertisements in local papers can be run to point up the solid advantage of electrical living, stressing the enjoyment and convenience offered by various appliances and bringing in the story of good wiring. If financing arrangements can be made with a local bank or loan institution, this might be explained in the ad. Joint advertisements sponsored by the contractor and a local loan institution, showing how a homeowner can get his home rewired on credit, can be the basis of a continuing campaign. Direct mail should also be included. Techniques, methods and actual literature to be used can be obtained by participation in various national home wiring programs sponsored by different segments of the electrical industry. And contractors should cooperate fully with trade allies—builders, electrical manufacturers, and electric utilities—to advance modern load-matched wiring and better electrical living.

NOTES

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